DOCTOR OF PHILOSOPHY

The Circular Capability Framework: Adopting Circular Economy in the Agri-food Supply Chain

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Award date:
2022

Awarding institution:
Coventry University

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PhD

February 2022

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A thesis submitted in partial fulfilment of the University's requirements for the Degree of Doctor of Philosophy

February 2022

Certificate of Ethical Approval

Applicant:

Niken Kusumo Wardani

Project Title:

Circular Economy Research and Development for Sustainable Supply Chain

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

13 February 2020

Project Reference Number:

P102541

ACKNOWLEDGMENT

This thesis would have been impossible without the people who gave their time to share their insights, expertise, experiences, and contacts with me during fieldwork. I am forever grateful, and all errors remain my own. My deepest gratitude goes to my Director of Studies, Professor Benny Tjahjono, for his endless support of my PhD project and my development as a researcher, his invaluable guidance, his confidence in my ability to succeed, his support by disseminating my project through conference and journal publication, as well as support concerning my wellbeing – thank you for opening the door of opportunity to make this PhD journey possible. My thanks also go to Dr David Bek as my second supervisor for the valuable advice and constructive feedback. I also want to thank Dr Jordon Lazell, my third supervisor, who brought his expertise to my research.

I appreciate the time and effort invested by all participants in this research, without whom my PhD would not be possible. This involves those who participated in the study as well as their friends who assisted in securing appointments and planning interviews.

While it is frequently stated that a PhD is a solitary endeavour, which became an arduous journey during the Covid-19 pandemic, I am fortunate to have found a community of fellow PhD candidates, Indoscholars, Professor Vanessa Gaffar, Deddy. Most of all, I am grateful to have met Dr Rosyidah; thank you for the countless chats and motivations. Thank you to dr. Dwi, for the endless inspiration and unwavering support. I want to thank my parents and Abah Aos, as I would not be here without their faith and unconditional love. I am also profoundly grateful to have Denni, Ratri and Sakina for being such lovely children to help make this dream come true. I hope this journey becomes their inspiration to push the boundary of knowledge.

ABSTRACT

This thesis aims to explain the mechanisms of how the agri-food supply chains in the developing world adopt Circular Economy (CE) to tackle food loss and waste (FLW) and the capabilities and resources they need to possess. The main contribution of this thesis lies in identifying the resource of strategic capabilities of Natural Resource-Based View (NRBV) as the antecedents of CE principles that have not been discussed in the literature, and thereby this thesis proposes the Circular Capability Framework. This thesis adheres to the critical realism paradigm as well as a natural resource-based view perspective. A multiple case study design was also adopted to elaborate on the theory.

The research strategy employed a combination of retroductive-abductive reasoning and basic qualitative description. Twenty cases of agri-food supply chains are selected using purposive sampling in Indonesia comprises upstream, midstream, and downstream stages. The data were gathered using semi-structured interviews triangulation, site visits, in addition to supporting documents, such as company websites and archives from previous research. Analysis is then conducted using within-case and cross-case template analyses. The thesis explains three strategies of NRBV and identifies the deployment of capabilities of its resources at the operational level and the links to CE principles.

The strategy is interdependent between pollution prevention and product stewardship, but they are not path-dependent. Therefore, NRBV that was initially postulated as sequential is not valid in this context. Unlike pollution prevention and product stewardship that are interdependent, sustainable development, which consists of two aspects such as technology innovation and social which aims to alleviate the poor, are considered separate from these two strategies. Most of the actors do not rely on sophisticated technology; adopting technology is not favourable due to high investment. The use of technology that is by investing in tomorrow's technology to reduce environmental impact is influenced by external pressure. Consistent with theory elaborating to remain receptive with data, this thesis found unanticipated findings of the digital technology adoption that is prevalent across supply chains.

Social aspect is not feasible to be the main avenue in developing a new market but rather as the social responsibility and inclusiveness of the community into the business. As a result, social responsibility is one of the principles that need to be augmented as part of relevant CE principles in tackling FLW. The main barrier is found to be lack of knowledge, structural, and financial that hindered the CE principles to be implemented. Whilst offering practicality by generating framework for CE adoption and conceptually relevant knowledge to the agri-food supply chain literature, the use of the NRBV theory offers a novel perspective by

conceptualising the Circular Capability framework in the agri-food supply chain that extends the existing discussion on the adoption of CE in the biological cycle and provide opportunities for future research.

Keywords: Agri-food supply chain, Case study, Circular Economy, Critical realism, Natural resource-based view, Qualitative research

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LIST OF ABBREVIATIONS

3R	Reduce Reuse Recycle
APRC	Regional Conference for Asia and the Pacific
APRINDO	*Asosiasi Penguasa Ritel Indonesia* (Association of Indonesian Retail)
BoP	Base of Pyramid
BPS	*Badan Pusat Statistik* (Central Bureau of Statistics)
BUMN	*Badan Usaha Milik Negara* (State-owned Enterprises)
CE	Circular Economy
CEBM	Circular Economy Business Model
CIMO	Context, Interventions, Mechanism, and Outcomes
CISL	Cambridge Institute for Sustainability Leadership
CO2	Carbon dioxide
COC	Certificate of Competency
CR	Critical Realism
CSC	Closed-Loop Supply Chain
CSR	Corporate Social Responsibility
DfE	Design for the Environment
DOI	Digital Object Identifier
E. coli	*Escherichia coli*
EBSCO	Elton B. Stephens CO
EMAS	Eco-Management and Audit Scheme
EMF	Ellen MacArthur Foundation
EoL	End of Life
EU	European Union
FAO	Food Agriculture Organization
FFC	Fresh for The Customer
FIFO	First In First Out
FLW	Food Loss and Waste
FVW	Fruit and Vegetables Waste
GAP	Good Agricultural Practices
GDP	Gross Domestic Product

GDPR	General Data Protection Regulation
GGHH	Global Green and Healthy Hospitals
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
ha	Hectare
HACCP	Hazard and Critical Control Point
HEPA	High Efficiency Particulate Air
HO	Head Office
IDR	Indonesia Rupiah
IG	Instagram
IPB	*Institut Pertanian Bogor* (Bogor Agricultural University)
IPM	Integrated Pest Management
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LIPI	*Lembaga Ilmu Pengetahuan Indonesia* (Indonesian Institute of Science)
LRQ	Literature Review Questions
MOU	Memorandum of Understanding
MUI	*Majelis Ulama Indonesia* (Indonesian Ulema Council)
NFT	Nutrient Film Technique
NGO	Non-Governmental Organisation
NOx	Natrium oxide
NRBV	Natural Resource-Based View
pH	Potential of Hydrogen
PKBL	*Program Kemitraan Bina Lingkungan* (Environmental Development Partnership Programme)
PKPHT	*Pusat Kajian Pengelolaan Hama Terpadu* (Integrated Pest Management Study Centre)
PLA	Polylactic Acid
PLN	*Perusahaan Listrik Negara* (State Electricity Company)
PO	Purchase Order
PSAT	*Pangan Segar Asal Tumbuhan* (Fresh Food from Plants)

PT KAI	*Perseroan Terbatas Kereta Api Indonesia* (Indonesian Railway Company)
PUM	Programma Uitzending Managers
QC	Quality Control
QDAS	Qualitative Data Analysis Software
RBV	Resource-Based View
RDT	Resource Dependence Theory
RZ	Rijk Zwaan (Rich Goose)
SCM	Supply Chain Management
SDG	Sustainable Development Goals
SLR	Systematic Literature Review
SME	Small Medium Enterprise
SNI	*Standar Nasional Indonesia* (Indonesian National Standard)
SO2	Sodium dioxide
SOP	Standard Operating Procedure
SUN	*Stiftungsfonds für Umweltökonomie und Nachhaltigkeit* (Endowment Fund for Environmental Economy and Sustainability)
TDS	Total Dissolve Solid
TQM	Total Quality Management
UK	United Kingdom
UN	United Nations
UNEP	UN Environment Programme
URL	Uniform Resource Locator
VOS	Visualisation of Similarities
WWF	World Wildlife Fund

CHAPTER 1 INTRODUCTION

1.1 Introduction to the agri-food supply chain

Agri-food refers to agricultural products that are destined for human consumption. Agri-fresh supply chain management encompasses the processes that take place from producing agri-fresh produce, to its distribution, to the consumer (Shukla and Jharkharia 2013). Due to the perishable nature of the produce, high volatility in demand and prices, growing customer concerns about food safety (Van Der Vorst and Beulens 2002), and reliance on climate conditions, the agri-fresh supply chain is more complex than other supply chain management (Aggarwal and Srivastava 2016). Globalisation, technical advances, trade deals, market consciousness, and environmental issues, as well as post-harvest wastage, are among the key factors that have recently drawn the attention of researchers and practitioners to the agri-food supply chain.

With current population growth rates, the global population may reach an added 3 billion people in 30 years (World Bank 2020). This may increase the pressure for supplies as not only does the risk of depletion of natural resources exist and as mentioned, the perishable nature of the produce, but also there is a lack of consensus between specifications of products, resulting in food waste. Food waste is often determined by aspects of quality among different stakeholders. These qualities differ and include in pest resistance and yield for producers, size and safety from retailers, nutritional benefits, subjective appearance, and consumer expectations (FAO 2020). Furthermore, the quality of products and the cost of production contribute to increasing the prices of products.

According to (FAO 2019) a significant amount of agri-fresh produce is thrown away at different supply chain stages. (1) The essence of development, which is partly dependent on biological processes, thus increasing uncertainty and risk, distinguishes agri-food supply chains from other supply chains. (2) the design of the commodity, which has perishability and bulkiness that necessitate a specific supply chain, and (3) social and consumer attitudes toward issues such as food safety, animal welfare, and environmental strain (Lusine Ondersteijn, Kooten, and Lansink 2006)

Numerous intriguing sustainability challenges have emerged along agri-food supply chains spanning multiple socioeconomic and environmental dimensions. Socioeconomic issues primarily affect local populations or consumers and include household income, food commodity price fluctuations, gender inequality, and health issues. Several other challenges include food shortages, pre/post-harvest losses, demand-supply imbalances, small landholdings, price increases, consumer demands for safe and nutritious foods, nutritional security, growers' access to market information, exposure to global opportunities for free trade or technology transfer, a lack of updated information and intelligence, and disorganisation and inadequacies. Any change in the market price of food can significantly impact a household's food security, particularly in the middle- and low-income countries. Food prices have fluctuated dramatically over the last decade, both in agriculture and aquaculture (Bhat and Jõudu 2019).

Price volatility can disrupt the continuous flow of food through the supply chain, which is a highly undesirable trait. Price increases have been associated with increased food insecurity and poverty, particularly among non-urban or rural consumers (Headey and Martin 2016). Nonetheless, several issues regarding the quality and safety of agri-food commodities continue to surface from time to time (both for fresh and processed food). Recent publications by eminent researchers provide excellent documentation of emerging food quality and safety issues in the agri-food supply chain (Bhat, Alias, and Paliyath 2012, Bhat and Gómez-López 2014).

Food wastage and loss also constitute a significant source of concern in the agri-food supply chain. Food loss can be defined as changes in the physical characteristics of a food, whereas waste can be defined as the inability to consume edible foods. The success of the agri-food supply chain remains uncertain unless all stakeholders (from farm personnel to consumers) make a concerted effort to understand the underlying issues and problems. Among the critical factors in supply chain management are linkages, collaborations, belief, teamwork, and transparency among the participants (stakeholders) (Bhat and Jõudu 2019).

The situation is exacerbated by the food security situation in Asia and the Pacific as a result of COVID-19, as well as the fact that the FAO in its 35th Regional Conference for Asia and the Pacific (APRC) calls for a more resilient food system, citing the need to re-examine the food system and value chain, as border restrictions and lockdowns are destroying livelihoods and impeding food transport during the pandemic. As a result, food loss and waste are increasing as growers are forced to discard perishables, and many urban residents are struggling to access fresh food.

1.2 Agri-food supply chain in Indonesia

Indonesia is a developing country with a rural area that is dominated by the agricultural sector and includes 32.9% of the employment level (Ridha, Burhanuddin, and Wahyu 2017); the agricultural sector is also the main foundation of the country as it provides about 87% of raw material from small-medium-sized enterprises, providing food for about 270 million people in

Indonesia, and contributing around 13.7% of the Indonesian GDP (Badan Pusat Statistik 2021). However, a problem that the agri-food industry in Indonesia has to overcome is that small-scale vegetable growers are generally experiencing some problems in improving the safety and quality of vegetables sent to top-end consumers in modern retailers (Rachman and Septiana 2020). Also, the horticulture establishment trend in Indonesia has decreased in some regions, as Figure 1 shows.

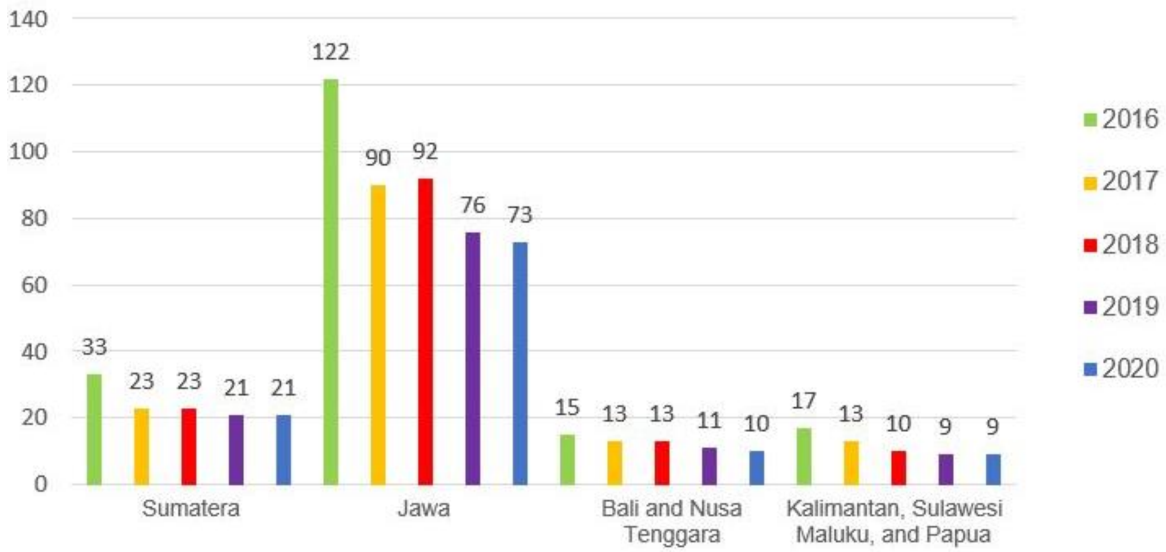

Figure 1 Horticulture establishments in Indonesia by island (Source: www.bps.go.id)

Besides the problems that growers have, many horticulture establishments also encounter the lack of a transportation system policy that supports a sustainable supply chain; it makes a sustainable mechanism seem hard to achieve. The ultimate goal of the sustainable food system is food security, better quality and safety for consumers and ensuring these goals depends on the food distribution system or efficient food supply chain (Rachman and Septiana 2020). According to the BPS 2020 census, the population of Indonesia has reached 270 million. This growing population suggests the need for ensuring food security. Moreover, it is found that certain crops that are classified as volatile food caused inflation in Indonesia, which required intervention from the central bank (Bank Indonesia 2020).

The way food is currently produced is unsustainable; moreover, food waste and food loss issues have emerged as a crucial issue for the food industry in East Asia and the Pacific region. The issue of waste has also been acknowledged as one of the characteristics in the supply chain of the agri-food industry; according to the Economist Intelligence Unit, Indonesia is the world's second-largest food waster, squandering nearly 300 kgs of food per person each year, second highest compared to Saudi Arabia in 2017. Indonesia is estimated produced up to 32,67 million ton of food waste from household, food service, and retail in 2021. Indonesia is one of the countries with poor management of food loss and waste in the G20, in the same condition with Brazil, Mexico, Turkey, and Saudi Arabia (Economist Intelligence Unit 2021).

The amount of waste and loss generated from various agri-food supply chains is considered mere waste, instead of being viewed as a new resource to be utilised; it still has possibilities to be processed into valuable input. In Indonesia, food waste management has not been done in an integrated manner, especially in relation to the reuse reduce recycle (3R) programme (Rachman and Septiana 2020); the 3R waste management strategy is also presumably ineffective in solving the waste problem (Nurafifah, Marlina, and Nugroho 2021). Whilst SDG 12.3 is related to overcoming FLW, United Nation specifically aims to halve global food waste per capita and reduce food losses along supply chains by 2030.

To improve the efficiency in the supply chain process, increase waste management performance and have a greater use of existing agricultural innovations and technologies, implementing a CE is perceived as being important (Nattassha et al. 2020). By promoting the adoption of closed-loop production patterns within an economic system, CE aims to increase resource-use efficiency, with a particular focus on urban and industrial waste, to achieve a better balance and harmony between the economy, environment, and society (Ghisellini, Cialani, and Ulgiati 2016).

Indonesia’s Minister of Agriculture explained Indonesia's four priorities in the "new normal" situation, highlighting the country's efforts to strengthen food security during the pandemic, to sustain the availability of food for all in the "new normal" era and develop a set of policies called four Ways of Action. The four priorities include increasing production capacity, local food diversification, strengthening the food reserves and logistics system, and developing modern agriculture (FAO 2020). In terms of economic performance, GDP from Agriculture in Indonesia decreased to 50413.10 IDR Billion in the fourth quarter of 2020 from 84333.20 IDR Billion in the third quarter of 2020, as shown in Figure 2.

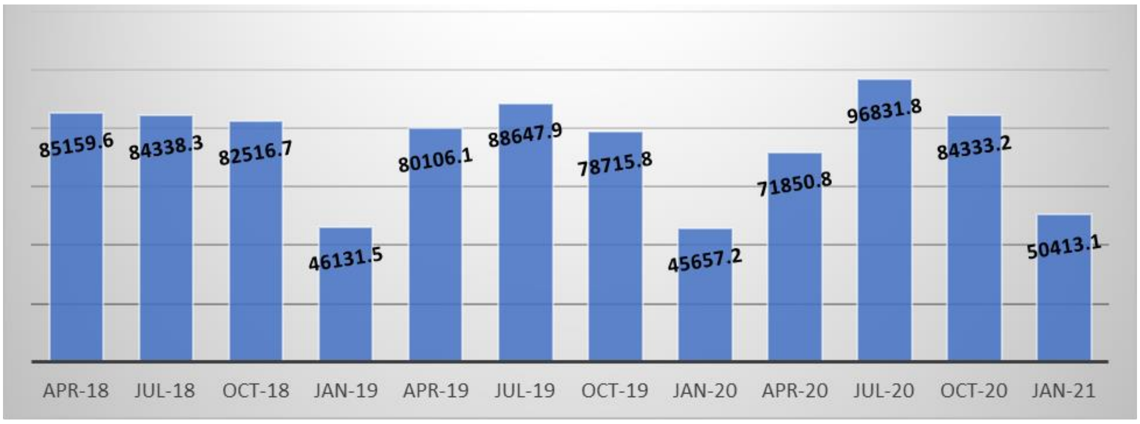

Figure 2 GDP in Agriculture Sector in IDR billion (Source: www.tradingeconomics.com)

Despite the global setback in achieving sustainable development goals (SDGs), Indonesia's ranking in the global food security index improved from 74th in 2015 to 62nd in 2019. The prevalence of stunting (malnutrition) declined from 30.8% in 2018 to 27.67% in 2019. The government emphasised strengthening their collaboration and supporting the FAO's Hand-in-Hand Initiative to contribute to attaining the SDGs in these challenging times. However, in 2021, Indonesia decreased again to 69th position (Global Food Security Index 2021).

Furthermore, modernisation of the agri-food system in Indonesia is following the trend in the Global South, indicated by the rapid rise in the number of supermarkets. The rapid expansion of modern food retail encapsulated in the so-called 'supermarket revolution' is often portrayed as a pivotal driving force in the modernisation of agri-food systems (Vetter, Larsen, and Bruun 2019). It is aligned with the global evolution; with the presence of the Internet having affected the business and economic situations; the communication technology changes have made electronic commerce the new way of selling products, where people can purchase online; e-commerce now represents the implementation of a new economy mechanism in the digital market.

Agri-food e-commerce is a result of food retail's continuous evolution from traditional stores to modern supermarkets to e-commerce. The transformation of fresh produce marketing using e-commerce in Indonesia is a new approach in the food chain. On the market side, the urban food market and rural-urban food supply chains are crucial to Indonesian food security; they proliferate and dominate the agri-food economy (Reardon et al. 2015). The external factors such as technological advancement and changes in customer behaviour have hugely impacted Indonesia's agri-food supply chain. The current pandemic situation has also transformed the way in which businesses work, increased awareness about the need for food security, and reduced food waste and loss; therefore, as Indonesia's agri-food system is also expanding, it is aligned with the urge to create a sustainable production.

This thesis is using Indonesia as an example, as it remains understudied. The adoption of CE offers a sustainability practice throughout the agri-food supply chain Indonesia. Given the magnitude and complexity of the issues in agri-food, this highlights the need for better resource and waste management as potentially advocated by adopting a CE in tackling FLW issue.

1.3 Lessons learnt from CE in agri-food supply chain

CE research is widely discussed in the literature on the agri-food supply chain, but a large proportion of the literature stream is regarding waste management. Lack of consensus was found in the literature on how to adopt CE and its principles, so it remains unclear despite most agreeing on practical guidance and the idea of CE's regenerative and optimisation models. Furthermore, the agri-food of the biological area is limited, particularly in research that employs a theoretical lens. Some existing literature in the context of a developing country, such as Indonesia, alludes to the use of waste rather than preventing it. There is no framework available to guide CE adoption, especially in the agri-food industry. Therefore, this thesis research aims to investigate CE in the agri-food supply chain, consisting of three different stages of the supply chain, in order to have a comprehensive picture of CE adoption.

1.4 Research gaps and proposed research

The agri-food supply chain has an important role in food security; however, it is a challenge to achieve sustainable production. CE seems a promising method of intervention in the current unsustainable practice of food production. The current discussions of CE in the agri-food supply chain are mainly on solving practical problems and waste management. There is an urgent need to address the problems caused by linear practices towards greater sustainability. The fact is that the current acquisition of natural resources to produce goods does not appear to be sustainable, including agri-food, which has a critical food security provision (FAO 2020). The WWF (2018) reported that today's humans live beyond Earth's carrying capacity. Therefore, this new alternative business model that is restorative by design, starts from the process of extracted natural resources, designs the waste and minimises pollution, and keeps products in the highest utility possible at all times, seems to be the solution to environmental strain and answers the single flow economy issue (EMF 2015). A dearth of empirical research on adopting CE suggests the need for research on how to adopt CE.

The mechanisms that underpin the adoption of CE are not fully understood. Therefore, this thesis aims to address both practical and conceptual research gaps, proposed a framework in adopting CE. This investigation takes the form of qualitative multiple case-study with semi-structure interview, comprises three stages of agri-food supply chains, growers, distributors, and modern retailers.

1.5 Research question and key concepts

This thesis attempts to provide answer to the following research question:

How do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?

Strategic capabilities refer to the theory of the NRBV coined by Hart (1995), who suggested the need for environmental concern regarding the business activities that may prevent gaining competitive advantages. The three significant strategic capabilities are pollution prevention, product stewardship, and sustainable development. The resources are continuous improvement, stakeholder integration, and shared vision.

Despite the debate on the definition of food loss and waste in academia, the (FAO 2019) defines food loss as the edible food that is lost during production and distribution, while food waste refers to food discarded at the retailer and consumer levels. This thesis adapts this definition such that FLW encapsulate food loss at sites of primary production and distribution, and food waste is from distribution to retailer. This thesis does not use these terms interchangeably, rather they are used together, via the term FLW, is accordance with the definition above. Using the term “food loss and food waste” (FLW) gives greater accountability by encompassing both food lost pre-farm gate and food wasted beyond farm gate in the supply chain. As Jurgilevich et al. (2016: 6) note, “the estimates of food waste differ throughout literature depending on the definition and what is counted”. Therefore, by using the encompassing term ‘FLW’ this thesis not only avoids the pitfalls of addressing food loss or food waste individually but is also able to give a holistic account of all food that does not achieve its primary purpose of being grown to feed humans within the supply chain being studied.

Many authors attempt to define the term CE simply as circularity. This new term has gained traction in academia and with practitioners (Ghisellini, Cialani, and Ulgiati 2016, Masi, Day, and Godsell 2017, Murray, Skene, and Haynes 2017). Despite the many definitions of CE, there is one common concept of a closed-loop system: the continuous flow of materials and energy in producing products and managing waste as the excess of production so that it could be converted into resources for other products. According to the Ellen MacArthur Foundation (2015) which is used by almost all papers in the literature. CE is motivated by the thought of resources being finite and that they could be better used (Geissdoerfer et al. 2018); it takes insights from living systems that there is no such thing as waste in living systems because one species' waste becomes another species' food (EMF 2015). Kirchherr, Reike, and Hekkert (2017) emphasise the critical nature of understanding the CE concept, yet its increasing popularity has led to claims of a diffusion in definition and concept as a whole. This prompted research to look further into the 114 definitions discovered by ways of quantification, with the aim of providing transparency, clear any misconceptions and help the understanding of the CE concepts.

Bek and Lim (2018) suggest that a firm that has embedded CE in its business is profitable and reduces risks associated with energy price and water scarcity. CE has its roots in concepts from industrial ecology, cradle-to-cradle and biomimicry (EMF 2015). Industrial ecology aims to create closed-loop processes which focus on natural capital restoration and social welfare. Cradle-to-cradle emphasises the effectiveness of a positive impact and reducing the negative consequences. Biomimicry has three fundamental principles: nature as a model, measure, and mentor.

Referring to the butterfly diagram from EMF (see Figure 3), there are two main and distinct concepts, although they share the same ideas of circularity. One side is the technical cycle and the other is the biological cycle and each has its own characteristics. The former is related to recycle, refurbish, and remanufacture, whilst the latter is related to living creatures and nature; accordingly, the approach of CE would not be the same. Based on the diagram, agri-food is located on the left in the biological cycle.

Figure 3 Butterfly Diagram (Source: EMF 2018)

According to Webster (2015) a CE has five principles as described below:

1. **Waste equal to food**. This means that waste from living things decomposes naturally into soil. Anaerobic digestion is used to convert waste into biogas.
2. **Build resilience through diversity**. All stakeholders involved in the business collaborate to create a symbiotic relationship rather than a competitive manner.
3. **Work with energy from renewable sources**. The process of producing products need to use renewable sources.
4. **Think in a system**. This means understanding how the parts influence one another and seeing opportunities to generate economic, environmental and social gains.
5. **Think in cascades**. The value creation of lies in the opportunity to capture the value from material through other applications. Such as the reuse of cotton clothing for upholstery.

This thesis adopts CE principles that were reformulated by Ripanti and Tjahjono (2019) in examining the adoption of CE as seen from the enactment of six CE principles: waste minimisation, cascades orientation, economic optimisation, maximisation of retained value, leakage minimisation, and environmental consciousness.

The term agri-food is used in many respects and refers to the agricultural crops destined for human consumption. There is inconsistency in segmenting agri-food products (Shukla and Jharkharia 2013); they argue that in current literature fresh produce includes flowers, fruits and vegetables. However, this thesis investigates only agri-food fruits and vegetables; following Aramyan et al. (2006), this study will therefore use the term agri-food only for these items. The agri-food supply chains consist of upstream (growers), midstream (distributors), and downstream (modern retailers).

1.6 Aim and objectives

The thesis aims to explain the mechanism of how the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess. To accomplish the aim, four objectives have been determined:

1. To identify the operational level of capabilities in the agri-food supply chain.
2. To explain the relationship between the capabilities in the agri-food supply chain and CE.
3. To identify the barriers in the adoption of CE in the agri-food supply chain.

4. To propose a CE adoption framework that is contextualised grounded in strategic management theory, the Natural resource-based view theory.

1.7 Summary of findings and contributions

This thesis found that the strategic capabilities of NRBV, in particular its resources, affect the adoption of CE and acts as the antecedents of CE principles. Several CE principles are enacted in the strategic capability of pollution prevention; waste elimination, maximisation of retained value, and economic optimisation. Product stewardship has the resource of stakeholder integration and is found to be dynamic amongst cases, resulting in the different enactment of CE principles; these are principles of cascades orientation, waste elimination, environmental consciousness, leakage minimisation, maximisation of retained value, and economic optimisation. This thesis found that most cases attempted to leverage their continuous improvement by exploiting their stakeholder integration mainly due to economic motives. A progression towards incorporating an environmental approach is exhibited but has yet to reach the same level across supply chains. Cascades orientations appeared across supply chains with different actions. Upstream has longer cascades actions compared to other chains, where the shorter actions are in the downstream because of inflexible procedures and being protective of the firm's reputation. As there is poor practice of landfilling, the principle of leakage minimisation is not being fulfilled in downstream, and material is lost; it cannot enter back into the supply chains in a circular way as it is suggested. This thesis argues that pollution prevention and product stewardship are interdependent as the sequence is implemented together and each complements the other; however, they are not sequential or path dependent, as originally conceptualised by (Hart 1995).

Sustainable development has the resource of shared vision and enacted three CE principle, there are waste elimination, economic optimisation, and social responsibility. Technology innovation entails reducing waste by investing in tomorrow's technology, although they are not a popular means for all actors as it requires significant investment, which is unappealing due to the slow progression of availability of economies of scale technology. Another factor is the volatile price of products that affect the uncertainty of return on investment; if there is external factor influence, such as customers, such investment can be allocated. This thesis found unanticipated findings related to sustainable development. The data found that digital technology adoption has become an emerging topic related to technology adoption. Digital technology accelerates information flow and coordination within a company and inter-organisationally, thus contributing to reducing waste. Digital technology is also used as part of the learning process, particularly having access to social media, which are used extensively for application in cultivation systems by upstream. Additionally, the online market is emerging as an opportunity for new distribution channels. In terms of social aspect, this aims to alleviate the “poor” in the form of empowering communities to become involved in business. There are four outcomes found in this thesis, where reduced FLW is a significant outcome appearing in all cases. Other outcomes include preserved natural resources, reduced GHG emission and global warming, and developing local economy, although they were not confirmed by all cases. As a social dimension is missing in the principles, social responsibility is therefore added as part of the CE principles, with the outcome of improving the local economy. The barriers are divided into several aspects, such as knowledge, structural, financial, supply chain. Barriers to knowledge occur because of the lack of understanding of agri-food supply chain actors on developing the necessary capabilities towards CE. Ultimately, this thesis contributes to knowledge by using NRBV as a theoretical lens in CE research, exploring capabilities in the supply chain, conceptualising the Circular Capability Framework for CE adoption in the agri-food supply chains, along with a set of propositions related to NRBV and three main resources that served as the antecedents of CE principles. The Circular Capability Framework can be used as a reference for practitioners, showing barriers that need to be acknowledged by company managers, and showing various outcomes that can be a reference for companies to implement CE and become a reference in inviting other stakeholders to collaborate. On a broader scale, this thesis can also contribute to providing information for the government in developing policies related to the transformation towards CE.

1.8 Summary of disseminated works

A modified version of the thesis has been disseminated in several ways as shown in Table 1. Some of the results of the thesis focus on the investigation of food waste and losses in agri-food supply chains. The journal paper generated the framework for a Circular Capability Framework, identifying the antecedents, principles, and outcomes of CE. The paper was submitted to the special issue on CE in the Journal of Business Research with the title A Circular Capability Framework to address food waste and losses in the agri-food supply chain: The antecedents, principles and outcomes of Circular Economy.

Another modified version of the thesis was presented at the 11th Annual International Conference on Industrial Engineering and Operations Management in Singapore 2021. The presentation focussed on the results of data analysis at the growers’ level. The conference proceedings title is Circular Economy Adoption in the Upstream Agri-food Supply Chain: Understanding the implications of the Two Theoretical Lenses. Both modified versions of the published papers are included in Appendix F.

Table 1 List of published and presented papers

Types of papers	Details	Notes
Journal	Kusumowardani, N., Tjahjono, B., Lazell, J., Bek, D., Theodorakoiuolus, T., Andrikoupulous, P., Priadi, C.R. (2022) 'A Circular Capability Framework to address food waste and losses in the agri-food supply chain: The antecedents, principles and outcomes of Circular Economy'. *Journal of Business Research* 142, 17-31	Published to Journal of Business Research on the special issue of Circular Economy in Small and Medium-Sized Enterprises - Theoretical Developments, Practical Challenges and Future Research Agenda
Conference proceedings	Kusumowardani, N., Tjahjono, B. and Priadi, C.R. (2021) *Circular Economy Adoption in the Upstream Agri-food Supply Chain: Understanding the Implications of the Two Theoretical Lenses*. 'Conference on Annual Industrial Engineering and Operations Management 11th'	Paper is presented online at the 11th Annual International conference on Industrial Engineering and Operations Management (IEOM) in Singapore March 7-11, 2021. The presentation is part of the thesis findings, represent the upstream level in the form of virtual presentation via zoom. The paper is published in the Proceedings and indexed by Scopus

1.9 Structure of the thesis

This thesis is structured into eight chapters **Chapter 1** is the introduction of the study context, the problems with the agri-food supply chain, and provides the reasons for the significance of the research, the research question, and objectives. **Chapter 2** covers the philosophical stance of critical realism and theoretical lens of the NRBV underpinning the research to understand the adoption of CE in the agri-food supply chain. **Chapter 3** presents a systematic literature review (SLR) to identify the research gap of CE in the context of agri-food. **Chapter 4** presents the methodology employed to answer the research question, comprising research design and strategy, samples selection, data collection, and data analysis. **Chapter 5** presents the findings of within case. **Chapter 6** presents cross-case analysis and the explanation of propositions against supporting cases, and refinement of the initial framework. **Chapter 7** presents a discussion of the findings in relation to the theoretical lens. **Chapter 8** covers conclusions of the thesis which consist of the main contribution of the thesis to the relevant agri-food supply chain literature; the second part is the limitations that can be the opportunities for a future research agenda.

CHAPTER 2 PHILOSOPHICAL AND THEORETICAL PERSPECTIVE

This chapter describes the underpinning of the philosophical and theoretical perspectives of this thesis. This thesis adopted critical realism as a philosophical stance and the NRBV as a theoretical lens. These philosophical stances and the theoretical lens serve as the basis to explain the causal mechanism of the research question “how do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?”

2.1 Critical realism as the philosophical stance

Critical realism is one of the philosophies commonly use in research for business studies, among other four major philosophical paradigms, i.e., positivism, interpretivism, postmodernism, and pragmatism (Saunders, Lewis, and Thornhill 2016). According to its definition, critical realism is “through theory and observation, and a result of previous experiments, they develop knowledge and understanding about the mechanism through which an action causes an outcome, and about the context which provides the ideal conditions to trigger the mechanism” (Robson 2002: 30). The key difference is to be highlighted within the concept of causality and its role to understand the phenomenon under investigation, where the primary objective is to provide clear, succinct and empirically supported statements about causation of how and why a phenomenon occurred (Wynn and Williams 2012). In this thesis, the descriptions of causality are achieved in two ways: the first attempts to explain the phenomenon by postulating the relationship between NRBV and CE by building the framework and propositions; the second is by generating explanations of how actors within the supply chain understand and interpret their role in a specific setting, and how subjective meanings are developed. The description of events is explained in the details of each case in the case study research.

While the movement of critical realism is claimed by Sayer, this paradigm was originally presented by Roy Bhaskar in 1975, in an attempt to answer the weaknesses of positivist and interpretivist. Critical realism has ontology realism and epistemology relativism (Sayer 2000). Ontology or “what is the nature of social reality?” exists independently suggesting that the reality is stratified into three overlapping domains: empirical, actual, and real (Bhaskar 1978). The metaphor of ontological depth is the iceberg that is illustrated in Figure 4. The empirical domain is the experience that can be observed or understood through human interpretation; actual includes events and actions, whether observed or not; and the real domain is the causal mechanism, structures, and relationships that generate events and empirical events, and exist independently (Ackroyd and Fleetwood 2000, McAvoy and Butler 2018) The role of the mechanism is “to generate the flux of phenomena that constitute the actual states and happenings of the world” (Bhaskar 1978: 34). Research on the supply chain of perishable cosmetics seasonal goods by Adamides, Papachristos, and Pomonis (2012) illustrates stratified ontology, i.e., the issue of high residue of inventory of the wholesaler that needs to be solved as the observed phenomenon. The empirical domain is the excess of the inventory, and the actual domain is the decision to order from the manufacturer, whereas the real domain is the underlying mechanism that generates the actual and empirical domains described, based on the theory they use, by using a system dynamic model.

Figure 4 Iceberg metaphor of stratified ontology in critical realism (Source: Fletcher 2017: 183)

The epistemology which translates into the query “How can we know what exists?” (Ackroyd and Fleetwood 2000) in critical realism, is “epistemic relativism”, which suggests that the world can only be known in terms of available descriptions. The goal of critical realism is the explanation of the mechanism that generates a certain event by uncovering the hypothesised existence of a mechanism which, if it existed and were enacted could have produced events (Bhaskar 1998). A critical realist study attempts to answer the question “What must reality be like in order for this event to have occurred?” (Wynn and Williams 2012)Therefore, to identify the mechanism that emerges from the components of physical and social structure to produce the events and ultimately to explain the interrelationship between them and the means, including the identification of the enabling conditions, stimulus conditions, and releasing conditions, are all important in critical realism.

It is evident there is growing interest in adopting critical realism in the operational research (Mingers 2000) using a qualitative case study (Adamides, Papachristos, and Pomonis 2012) that can reveal the underlying mechanism (Easton 2010). The flexibility of choice of research methods in critical realism is also one of the reasons this thesis adopts this stance. The research method depends on the nature of the study and the objectives the researcher wants to understand (Sayer 2000). In line with McDougall, Wagner, and MacBryde (2019), who adopted critical realism to study UK agri-food using the theoretical lens NRBV, this thesis believes that NRBV exists independently and can be discovered to support the theorisation of the circular supply chain in the agri-food sector by conducting a qualitative case study. The purpose of case study research in this thesis is to elaborate on the theory of NRBV, refer to Ketokivi and Choi (2014), the use of case research in theory elaborating meets the duality criterion. While maintain disciplinary of theory from data collection, that situationally grounded but also seeks the generality.

One of the principles of critical realism is retroduction, i.e., the way in which analysing the data is abductive retroductive. Retroductive inference is successful to “modify, support, or reject” existing theory to provide the most accurate explanation of reality (Fletcher 2017). Retroduction provides theoretical explanations that are assessed empirically (McAvoy and Butler 2018); they further explain retroduction and retrodiction to show the different stages of the level of analysis. The latter refers to the cross-case analysis.

Even though adopting a critical realist provides flexibility, Easton (2010) explained the importance of guidance when doing case research from a critical realist standpoint. First is by defining the research question, identifying the events, then entities, collecting data, analysis, followed by the explanation, as illustrated in Table 2. In a slightly different approach, McAvoy and Butler (2018) presented the critical realist processes which are divided into three steps: the first step is developing the a priori framework using existing theory and predicting the impact; the second is, through observations and retroduction, re-examining the framework for each case; and the last step is combining individual cases to create a cross-case where differences are examined to generate an explanation of the mechanism.

Table 2 The sequence of conducting case research in critical realism

The process of conducting case research in critical realism	Description
Design	Defining the research question, identifying events, identifying entities
Investigation	CR research shares the concern for contextualised social and cognitive processes of interpretive designs. Thick description and employs an abductive design systematically iterating between data, context and theoretical frameworks to capture as many of the different layers of data as possible
Analysis	Retroduction is the key epistemological process through the identification of mechanisms that explain what caused or relationship events

Explanation	Seeking an explanation requires that the researcher goes back to the research site collecting more data until epistemological closure, however flawed and temporary is obtained

2.2 Natural resource-based view as a theoretical lens

This thesis uses a theoretical lens that stems from strategic management theory to explain the underlying mechanism adoption of CE in the context of the agri-food supply chain; this is the NRBV which is the spin-off theory of the resource-based view (RBV) (Barney 1991, Wernerfelt 1984). Firms have a bundle of resources and capabilities that have characteristics of valuable, rare, inimitable resources, that are non-substitutable to achieve competitive advantage (Barney 1991). However, Hart (1995), who also used the same language of RBV when referring to the causally ambiguous and socially complex set of resources, argued that it would cause excessive exploitation and damage the environment, and the competitive advantage may be hindered through being constrained by the natural environment. He argued:

> "…this omission has rendered existing theory inadequate as a basis for identifying important emerging sources of competitive advantage. The goal is, therefore, to insert the natural environment into the resource-based view – to develop a natural resource-based view" (Hart 1995:987).

The first development of this theory conceptualised three interconnected environmental strategies: pollution prevention, product stewardship, and sustainable development (Hart 1995). Arguably, since NRBV was first developed, there has been a paucity of research using this theory; then since Hart and Dowell's (2011) paper reviewing the current state of NRBV, apparently influenced research to use this theory which reached a peak of 13 publications in 2018 and 2019, as illustrated in Figure 5. This thesis examined 35 papers considered relevant to the Researchers who use NRBV theory who highlighted the importance of the interaction of firms with the natural environment. Firms must be aware that their activities have an impact on the environment thus, the main quest is how to integrate environmental strategy into the firms' operations. In 2018 and 2019, all papers mentioned the importance of sustainable operations. Out of 35 papers in total, six are conceptual, including four written by Hart. The dominant research method was quantitative, with eight papers using a survey to measure the relationship between strategy and performance, one paper utilised life cycle analysis research, 11 used the qualitative method, and five papers used mixed methods. This shows that only a few empirical research has used NRBV. This implies that this theory is interpreted too abstractly to translate it into different points of view. Some of the references (Aboelmaged and Hashem 2019) combine with another theory that may be considered more established in order to meet the specific context and objectives of the research.

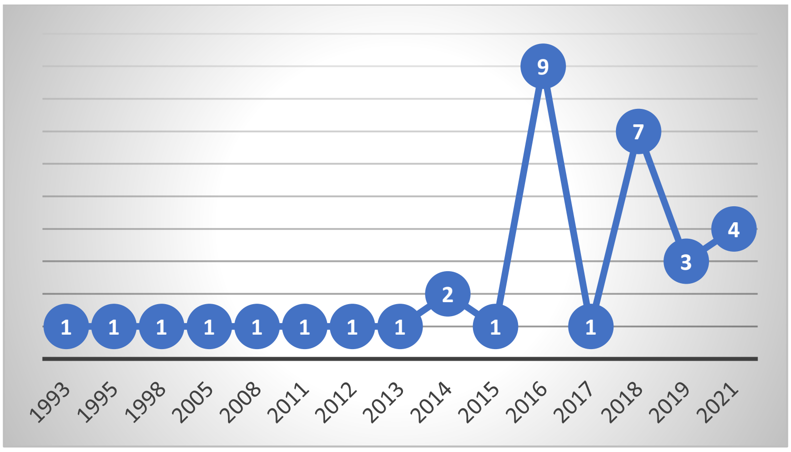

Figure 5 Number of published papers using NRBV theory

2.2.1 Pollution prevention

Pollution prevention is a proactive strategy to control and prevent pollution, waste, and emissions at the production stage. As such, the implementation of pollution prevention includes re-engineering business processes, installing environmental technologies to improve operational efficiency, and promoting environmentally friendly products to effectively utilise organisational resources (Chan et al. 2016, Hart 1995, Lai, Cheng, and Tang 2010, Wong et al. 2012). Pollution prevention related to the internal production and operations of the firms is similar to total quality management (TQM). In TQM, improving other intangible aspects such as waste of time processes are included as waste that needs to be prevented. By improving operational performance firms will gain significant cost savings and a better utilisation of input.

Hart (1995) suggests a reliance on process improvement by better housekeeping, using substitute materials. He mentioned the importance of employee involvement and highlighted the culture, such as environment commitment and top-level management attitude, as integral parts of pollution prevention. The key resource is continuous improvement (Hart 1995), suggesting an incremental process within firms.

2.2.2 Product stewardship

Product stewardship strategy has the same idea as pollution prevention but operates at supply chain level, where it suggests the "voice environment" considering the impact of producing products has impacts on the natural environment. Hence, the source of material input, product design, product development, to end-of-life treatment must all be carefully considered so as to prevent a negative impact on the environment. Product stewardship emphasises product life cycle environmental cost reduction and competition pre-emption, and allows collaboration with suppliers, customers, or other key stakeholders beyond the internal organisation (Hart

1995). Product stewardship proactively seeks to include environmental stewardship (Bhupendra and Sangle 2016). Life cycle assessment (LCA) could be applied to analyse environmental impact (Dicuonzo et al. 2020, Hart 1995). As such, firms can use sustainable material, non-toxic material, redesign their products, employ effective reuse, recycle, and disposal, thus shifting to an environmental end-of-life (Hart 1995).

Product stewardship involving the relationship among stakeholders involves a planning process and the development of products that are environmentally friendly; this includes the supply chain, government, media (Hart 1995) and end customers (Ashby 2018). Also design for the Environment (DfE) at the start of the supply chain leads to a more proactive and integrated response to environmental sustainability by looking for product functionalities, using fewer natural resources and having minimal environmental impact (Ashby 2018). Product stewardship also refers to incremental changes in product innovation (Cristina De Stefano, Montes-Sancho, and Busch 2016) centred on improving existing products and services (Hart, Milstein, and Caggiano 2003) but without altering the final output (Dicuonzo et al. 2020). As a result, improvements and value are actualised quickly in stronger community ties, credibility, and brand image (Golicic and Smith 2013). Collaboration can lead to technology transfer and resource efficiency to achieve clean technology (Mishra, Chiwenga, and Ali 2019). Shi et al. (2012) underline those closer relationships have a significant impact on improving financial outcomes. The involvement of external stakeholders in creating environmentally friendly products suggests that product stewardship acts as a source of differentiation of firms by securing access to raw materials. Therefore, a key resource is stakeholder integration (Hart 1995).

2.2.3 Sustainable development

Sustainable development entails two different aspects. The first is technology innovation that can be used for reducing negative impacts to the environment, e.g., the use of advanced technology to achieve clean technology performance, such as renewable energy. Clean technology is associated with radical or disruptive changes (Cristina De Stefano, Montes-Sancho, and Busch 2016), but with innovation, clean technology encourages modification of the existing products and redefines the production process (Dicuonzo et al. 2020), innovations that leapfrog standard routines and knowledge (Hart, Milstein, and Caggiano 2003). Therefore, firms need to find new capabilities to use sustainable technology that supports the implementation of clean technology to reposition their skills for the development and exploitation of future markets (Hart, Milstein, and Caggiano 2003).

The development of renewable energy potentially replaces dependence on fossil fuels, natural resources, and toxic materials in a more sustainable way (Hart and Dowell 2011). Renewable technologies include solar, wind, and biologically based polymers to enable renewable feedstocks such as corn to replace petrochemical inputs in plastics manufacturing. Scharfy, Boccali, and Stucki (2017) explained that in the agriculture sector the use of clean technology includes wind turbine, drip irrigation, hydropower, and biofuels. Substantial high investment may be required when firms start using clean technology (Hart and Dowell 2011).

The second aspect is social concern, which suggests that meeting the needs of the base of the pyramid customers refers to the context of poverty in developing countries (Dembek, York, and Singh 2018). Arnold and Valentin (2013) state that people who fall into the “poor” bracket are those who are living as defined by the World Bank. Refer to Hart’s (1995) proposition of sustainable development, where firms need to understand the market and create products that are affordable yet profitable for firms, thus exploiting future markets may empower entrepreneurial actions. However, some of the references assert the ethical issue of exploiting the “poor” as being advantageous for firms (Arnold and Valentin 2013).

Dembek, York, and Singh (2018) illustrated the base of pyramid as creating products for the “poor”, followed by expanding distribution channels. The second model responded with greater empowerment that is more bottom-up than top-down. The third approach is integrating environmental sustainability to achieve the triple bottom line. The implications of creating social concern within the business model include identifying capabilities needed to specifically design and modify the products to meet the needs of low economy consumers (Hart and Dowell 2011). Collaboration is a way to improve capability and possibly to go beyond a higher level such as with financial institutions, non-government organisations (NGOs) or government (Chesbrough 2006, London and Hart 2004). However, this strategy is still in the realms of concept and needs empirical research to answer the ambiguity of this strategy.

2.2.4 Identifying strategic capabilities in NRBV

To understand what capabilities are needed to support the implementation of environmental strategies, it is necessary to identify what capabilities have been discussed in the literature, however, this is scattered and some implicitly consider that most papers conducted empirical research to test the link between environment strategy with performance. Table 3 depicts the strategic capability, societal driving force and competitive advantage for each of the strategies.

Table 3 The Natural Resource-Based View (NRBV) strategic capability, key resource and competitive advantage

Strategic capability	Societal Driving Force	Key Resource	Competitive Advantage
Pollution prevention	Minimise emissions, effluents, and waste	Continuous improvement	Lower costs
Product stewardship	Lower product life cycle cost	Stakeholder integration	Reputation/legitimacy
Sustainable development	Make quantum-leap improvement	Disruptive change	Future position
	Meet unmet needs of the poor	Embedded innovation	Long-term growth

Source: Hart 1995

In his theory development of NRBV, Hart (1995) explained that the NRBV strategy is interconnected and path dependence. This suggests that one strategy will depend on other strategies. For example, pollution prevention is the first step that the firm needs to be implementing before the firm can apply product stewardship and sustainable development. Figure 6 illustrated the path dependence of the NRBV strategy.

Figure 6 The interconnectedness strategic capabilities (Source: Hart 1995:1005)

This thesis classified NRBV literature found in 35 papers which are divided into research topics as depicted in Table 4.

Table 4 Research topic using NRBV

Research topic	Sub-topic	Industry	Authors
Environmental practice in the supply chain	Sustainable supply chain	Conceptual	Golicic and Smith (2013)
		Manufacturing	He et al. (2019)
	Closed-loop supply chain	Clothing industry	Ashby (2018)
		Carpet tiles and composite textiles	Miemczyk, Howard, and Johnsen (2016)
Innovation	Eco-innovation	Hospitality	Aboelmaged (2018a); Wang, Font, and Liu (2020)
	Green innovation	Small medium enterprises	Aboelmaged and Hashem (2019)
	Internal innovation	Fashion industry	Dicuonzo et al. (2020)
	Technological innovation	Automobile industry	de Stefano, Montes-Sancho, and Busch (2016)
Corporate social responsibility	Safeguarding natural resources	Manufacturing firm	Menguc and Ozanne (2005)
Base of pyramid	Business model	Multi industry	Dembek, York, and Singh (2018)
	Conceptual	Conceptual	Prahalad and Hart (2002), Hart (1997); Hart and Dowell (2011)
	Firm performance	Manufacturing	Adomako, Ning, and Adu-Ameyaw (2021)
	Sustainable supply chain in BoP	Review paper	Khalid et al. (2015)

Considering the aim of this thesis is to identify what capabilities are needed in adopting CE in tackling FLW, it therefore this thesis examines the capabilities identified in the literature that utilise NRBV as theory as shown in Table 5.

Table 5 Capabilities of NRBV strategy

NRBV strategy	**Capabilities**	**Authors**
Pollution prevention	Employee skills	Hart (1995); Hart, Milstein, and Caggiano (2003); Yunus, Erlinda, and Michalisin (2016)
	Better housekeeping	Hart (1995); Bhupendra and Sangle (2016); McDougall, Wagner and MacBryde (2021)
	Total quality management	Hart (1995); Hart, Milstein, and Caggiano (2003)
	Monitoring	Graham (2018)
	Learning process	Graham (2018): Iqbal and Ahmad (2021); Latan et al. (2018)
	Management commitment	Brulhart, Gherra, and Marais (2017); Imran et al. (2019); Menguc and Ozanne (2005); Zheng et al. (2020)
	Sustainable orientation	Aboelmaged and Hashem (2019)
	Top manager attitude	Dicuonzo et al. (2020): Iqbal and Ahmad (2021): Khan et al. (2020); Wang, Font and Liu (2020)
	Eco-learning capability	Latan et al. (2018)
	Environmental integration	Graham (2018)
Product stewardship	Selection of green raw material	Hart (1995); Hart and Dowell (2011); Miemczyk, Howard, and Johnsen (2016); Song, Yu, and Zhang (2017)
	Supplier selection	Hart (1995)

	Life cycle analysis	Hart (1995)
	New product development	de Almeida et al.(2021) Hart (1995); Khan et al. (2020)
	Innovation capability	Imran et al. (2019); de Stefano, Montes-Sancho, and Busch (2016)
	Collaboration capability	Aboelmaged and Hashem (2019); de Almeida et al (2021); Graham (2018): Mishra, Chiwenga, and Ali (2019); Miemczyk, Howard, and Johnsen (2016)
	Strategic alignment capability	de Almeida et al.(2021)
	Interdepartmental integration	Dicuonzo et al. (2020); de Almeida et al. (2021); Hart (1995); Hart and Dowell (2011)
	Absorptive capability	Bhupendra and Sangle (2016); de Almeida et al. (2021)
	Knowledge sharing capability	de Almeida et al. (2021); Hart (1995)
	Information sharing	Zheng et al. (2020)
Sustainable development	Technology innovation	Hart and Dowell (2011); de Stefano, Montes-Sancho, and Busch (2016); de Almeida et al. (2021); Zheng et al. (2020)
	Expand collaboration to external stakeholder	Hart and Dowell (2011)
	New market for BoP consumers	Hart and Dowell (2011)
	Innovative product	Adomako, Ning, and Adu-Ameyaw (2021)
	Marketing capabilities	Getnet et al. (2019)
	Empowering capability	Arnold and Valentin (2013)
	Partnership with NGO	Chesbrough (2006); Hart (1997); Hart and Dowell (2011)

NRBV is used in a few studies such as green service (Chan et al. 2016), apparel (Fowler and Hope 2007), closed-loop supply chain (Miemczyk, Howard, and Johnsen 2016), and the implementation of an environmental strategy study in the UK agro-food supply chain (McDougall, Wagner, and MacBryde 2019). Some papers also combine NRBV with other theories. The most widely found is that NRBV is paired with dynamic capability because the authors have a point of view that firms require a dynamic capability strategy to modify their resources and suggest that firms need to have sensitivity in response to the rapid business environment changes. Table 6 lists the studies of NRBV combined with other theories.

Table 6 Research using NRBV with other theories

Theory	Reason	Study context	Authors
Absorptive capacity	Most innovative firms observe and employ new knowledge from other organisations	Broad range small-medium enterprises	Aboelmaged and Hashem (2019)
		Manufacturing	Bhupendra and Sangle (2016)
Dynamic capability	Driving forces as respond to rapid changes in the business environment	Hospitality industry	Aboelmaged (2018a); Wang, Font, and Liu (2020)
		Manufacturing	Miemczyk, Howard, and Johnsen (2016)
		Agri-food industry	McDougall, Wagner, and MacBryde (2021, 2019)
		Small-medium enterprises	Igbal and Ahmad (2021)
Institutional theory	A new perspective to environmental performance	Energy service industry	Zheng et al. (2020)

Stakeholder theory	Role stakeholder to further understand the role in adopting environmental practices	Manufacturing	Jabbour et al. (2020)
Resource dependence theory	The organisation depends on the environment for survival and should collaborate to combine their resource	Agri-food sector	Matopoulos, Barros, and van der Vorst (2015)
Signaling theory	To understand how shareholders, perceive specific benefit from green information technology	Manufacturing, service and communication industry	Nishant, Teo, and Goh (2017)

However, returning to Hart's (1995) postulation that future competitive advantage is rooted in "capabilities that facilitate environmentally sustainable economic activity" (p. 991), this thesis argues that NRBV contains a set of capabilities and therefore there is still much to be excavated. Furthermore, Hart's (1995) paper stated clearly that NRBV is a proactive strategy consisting of the elements of so-called strategic capability. Aragon-Correa and Sharma (2007) stated that a proactive environmental strategy is a dynamic capability. Dynamic capability is appropriate to use if the environment industry is itself very dynamic and rapidly changing, but for more stable industries, dynamic capability becomes less appropriate to be used as a theoretical lens (Hart and Dowell 2011). Moreover, this thesis argues there is a limitation to NRBV theory, which is still in the conceptualisation stage and lacks empirical research. The use of NRBV in the study of the CE phenomenon is considered a contribution to knowledge using theory elaboration in case research.

2.3 Circular Economy and NRBV

Few theoretical lenses have been used to study CE, such as stakeholder theory, social network, and knowledge-based view, all dynamic capabilities that depend on the research's purpose. One example is the study of CE employing stakeholder theory to understand the value network for industrial symbiosis (Hein et al. 2017). As the thesis aims to explain the adoption of CE in the agri-food supply chain, it argues that NRBV is the appropriate theoretical lens for the study of CE adoption. The CE or simply circularity shares common principles with NRBV. CE can be summarised as the regenerative alternative business model form of linear economy, i.e., "take-make-dispose", that utilises the natural resources prudently, and minimises waste, emissions and pollution, to prevent negative externalities; this could be achieved by product design.

Pollution prevention advises the control and prevention of waste, pollution, and emissions; this principle corresponds to that of the CE principle of waste minimisation. Whilst CE in the technical cycle is considered to be more advanced compared to the biological cycle, this suggests the need for more research in the biological cycle, which is the contribution of this thesis. This thesis posits that NRBV is the root of CE, considering the same principles between both as shown in Table 7.

Table 7 Similar features between NRBV and CE

NRBV	Feature	CE
Growing of ecological problems due to scope and scale of human activity and environmental damage (Hart 1995, Hart and Dowell 2011).	**Underlying motives driving forces**	Decouple growth from the consumption of finite resources due to population increase (EMF 2013a, 2015)
Theory of competitive ad-vantage based upon the firm's relationship to the natural environment (Hart 1995).	**Definition**	CE is an economy designed to preserve and enhance natural capital and optimise resource yield by managing finite stocks and renewable flow (EMF 2013a)
• Pollution and waste prevention • Raw material selection • Minimise life cycle cost, easy to compost • Avoid toxic materials use • Product design life cycle approach (Mena et al. 2014, Rodrigues et al. 2021, Hart 1995).	**Principles**	• Waste elimination (Teigiserova, Hamelin, and Thomsen 2020) • Design out waste (Cristóbal et al. 2018, EMF 2013a) • Leakage minimisation (Genovese et al. 2017) • Keep products and materials in use (De Angelis, Howard, and Miemczyk 2018) • Regenerate natural systems (Farooque, Zhang, and Liu 2019)
Competitive advantage through cost leadership and differentiation (Hart 1995).	**Corporate pay off**	• Economic • Environmental • Social (Homrich et al. 2018) • Competitive advantage (Cost leadership and added customer value) (Frodermann 2018)
Socially complex, involving extensive stakeholder (Ashby 2018, Hart 1995)	**Partnership strategy**	Collaboration is the enabler for CE (Mishra, Chiwenga, and Ali 2019)

2.4 Summary of the philosophical stance and theoretical perspective

This chapter has explained the philosophical stance adopted in this thesis: critical realism that is appropriate to answer the research question to explain the CE adoption mechanism in agri-food supply chains. One of the reasons for adopting critical realism is the flexibility in selecting the research design. Following that, the linkage between the philosophical stance of critical realism and the theoretical lens of NRBV with the phenomenon observed has been described. This chapter also justifies how this thesis contributes to the literature by extending the application of NRBV as a strategic management theory in the study of CE in the operations management field.

CHAPTER 3 SYSTEMATIC LITERATURE REVIEW

A systematic literature review (SLR) is utilised in this study as an alternative approach to give a clear understanding of what is known or not known in current academic publications regarding the CE in the agri-food supply chain. The approach is used in order to find similar interests of research by the process of searching, selecting, mapping, and examining (Tranfield, Denyer, and Smart 2003). SLR was initially proposed by a group of health service researchers that applied the evidence-based policy (Durach, Kembro, and Wieland 2017). This technique requires exhaustive, thorough, and comprehensive searching, so that the context of the study will be clear, capture state-of-the-art research regarding the topic, have the potential to be transferred into various contexts, and also identify knowledge gaps that inform future research (Tranfield, Denyer, and Smart 2003).

Although some argue that SLRs are usually employed in the science discipline, many researchers have used this approach in social science. Therefore, Tranfield, Denyer, and Smart (2003) suggest four revised systematic review principles that are more appropriate for management and organisation studies. These include transparency, inclusivity, explanatory, and a heuristic nature. These principles advise management and organisation studies to be open and detailed in every step of the research, with explicit topics to avoid similar findings and validity threats. The principles of an SLR are replicable, exclusive, aggregative, and algorithmic. Table 8 provides a comparison of conventional literature reviews and SLRs.

Table 8 The comparison of conventional and systematic literature reviews

(Source: Tranfield, Denyer, and Smart 2003)

The processes of conducting an SLR adapted from Tranfield, Denyer, and Smart (2003) can be simplified into three main stages: planning, conducting, reporting (Bennett et al. 2005, Bimrose, Barnes, and Brown 2005). Figure 7 shows the processes of conducting SLR.

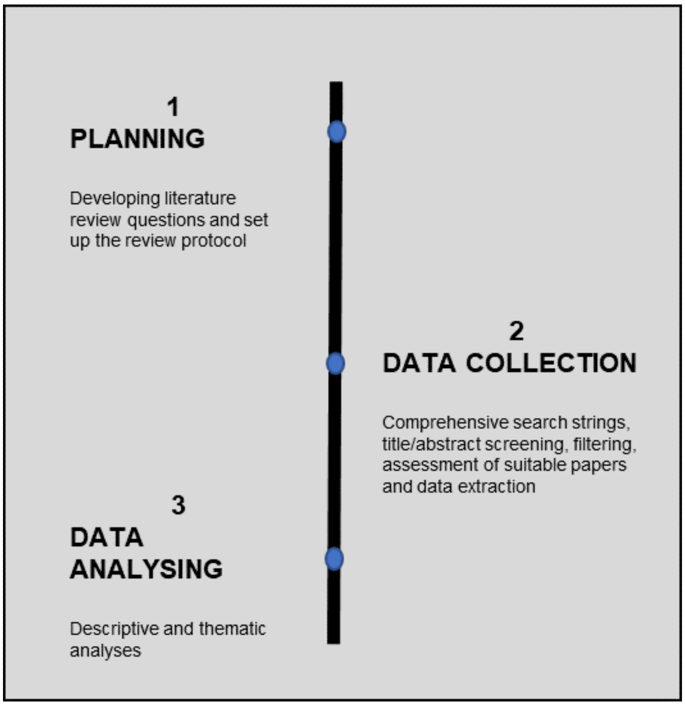

Figure 7 The steps in an SLR

3.1 Sustainability and Circular Economy

The industrial revolution has made people exploit natural resources at a rate higher than the pace of the natural capabilities of replacement. The exploitation of resources for human consumption has led to take-make-dispose habits. This approach is known as a linear economy, meaning that manufacturing industries take the natural resources from the earth, convert them into products, and dispose of the products in landfill at their end-of-life. The linear economy has existed for hundreds of years in human civilisation, but today's human beings live longer than those of some decades ago, resulting in a population explosion; today's world population has reached about 7.8 billion (United Nations 2019). The commencement of the Anthropocene has triggered the invention of the concept of sustainability by environmentalists in response to environmental and social impacts in the 20th century.

According to Brown (1987), sustainability can be defined in many ways, depending on the context. Geissdoerfer et al. (Geissdoerfer et al. 2018) mentioned that the scope of sustainability is broad and encompasses three bottom lines: economy, environment, and social. A significant amount of research in sustainability to overcome the challenges has been found in academic literature. One movement is to reduce, reuse, and recycle; nonetheless, these actions are insufficient to answer the global problems of how to fulfil demand while preserving the natural resources at the same time. The emergence of the CE enables the concept of sustainability, as it offers viable methods and can be measured. The concept of "Restorative, regenerative manufacture by design" means that the business model needs to be redesigned and restructured in such a way that manufacturers produce the products from the beginning of the extracted raw material and throughout the value chain. This implies that the materials used have to be degradable, and leakage of resources must be minimised by refurbishment, remanufacturing, and closing the loop. Arguably, the CE is a new industrial revolution paradigm in the history of human civilisation.

Geissdoerfer et al. (2018) explained the types of relationship between the CE and sustainability in three general directions: conditional, beneficial, and trade-off. Conditional involves the CE being the main solution for the sustainable system; beneficial relationship suggests that the CE is one among several solutions for sustainability; and trade-off means that the CE can also lead to negative outcomes, such as additional costs to recycle. In this sense, the CE leads to the needs of re-structuring business-as-usual and allows all entities to rethink and redesign the business model.

Some authors often address a multitude of goals largely depending on their interest, suggesting that sustainability goals are open-ended (Geissdoerfer et al. 2018). This is considered as one of the limitations of sustainability (Merli, Preziosi, and Acampora 2018). Moreover, Sauvé, Bernard, and Sloan (2016) claim that sustainability is failing to achieve its goal. It is argued that the CE does not just involve the operationalisation of companies and governments but could also lead to massive changes through the disruption of the old-fashioned economy paradigm, ultimately enabling all stakeholders to enter a new era. As confirmed in a review study by Merli, Preziosi, and Acampora (2018), the CE offers wider goals for economics and the environment. The CE also potentially leads to a shift from the traditional manufacturing industry to the new business model service industry, where current research with respect to the triple-bottom line in the CE has attracted the attention of scholars. Looking closer at the definition of CE, Moraga et al. (2019) breaks down the CE definition into sensu stricto and sensu latu, in which CE entails two definitions: narrow and broad. The narrow definition focuses on the circular flow closed loop, whilst the broad definition has a wider focus push towards sustainability aiming to achieve the three dimensions of sustainability.

The term agri food, referring to the agricultural crops destined for human consumption, is used in many respects. Shukla and Jharkharia (2013) identified inconsistencies in segmenting agri-food products, arguing that current literature deemed fresh produce as flowers, fruits, and vegetables. However, following Aramyan et al. (2006), this study will use term agri food for vegetables and fruits, in which they are categorised as perishable products. The perishable products' supply chain is more complex compared to most product supply chains and more difficult to manage because of its short shelf life, meaning products deteriorate over time (Aung and Chang 2014, Karaesmen, Schelter-Wolf, and Deniz 2011). The agri-food industry needs to transform to more sustainable practice, such as reducing food loss and waste along the supply chain (Esposito et al. 2020). The five main elements in the food supply chain are food production, distribution, commerce, consumption, and disposal (Irani and Sharif 2018).

3.2 Literature review questions

The SLR follows a sequence that begins with planning; this includes formulating literature questions and planning the method. The systematic literature review follows Context, Intervention, Mechanism, Outcome (CIMO) logic (Tranfield, Denyer, and Smart 2003) in developing the research question. Consistent with the philosophical stance of critical realism, a causal relationship to find the state-of-the-art of the CE in the context of agri-food supply chain results in the main literature review question (LRQ):

How can Circular Economy achieve sustainable production in agri-food supply chain?

To answer the main LRQ, the questions need to be broken down into several sub-questions. A few studies have stated that the CE concept is evolving in terms of definition, boundaries, principles, and associated practices, which needs to be consolidated (Merli, Preziosi, and Acampora 2018). Currently, the CE concept carries a multitude of meanings. In this sense, to reveal the definition of the CE in the context of agri food is imperative; therefore, the first literature review question is:

LRQ 1: What is the understanding of Circular Economy in the context of the agri-food industry?

The current economic model, the linear economy that refers to the pattern of take-make-dispose, has been criticised for having a detrimental effect on the environment, reaching the point where the natural environment seems unable to recover from the current level of exploitation (Sariatli 2017). The EMF (2013a) asserts that not all materials used are incorporated into final products, because they are lost during the production process. This condition pushes the need to exert an alternative economic model - the CE. The question then arises regarding what the principles of the CE entail. Thus, the next literature review question is:

LRQ 2: What are the principles of Circular Economy in the agri-food supply chain?

Having found the principles of the CE in the context of the agri-food supply chain, the next step is to identify the outcome by adopting the CE in the agri-food supply chain. Accordingly, the next literature question would be:

LRQ 3: What are the outcomes of Circular Economy in the agri-food supply chain?

In order to move towards a CE, it is imperative to understand its barriers. It is critical to understand current industry barriers in order find the mechanisms required to support the industry towards the transition to a CE. Hence, the question is:

LRQ 4: What are the barriers adopting Circular Economy in the agri-food supply chain?

3.3 Systematic literature review strategy

This section explains the data collection in the SLR, which involves selecting databases, setting up the review protocol, and inclusion and exclusion criteria. Several characteristics need to be taken into account when retrieving literature in supply chain management: theoretical boundaries, unit of analysis, source of data, context of study, definitions and the operationalisation of constructs, and research methods (Durach, Kembro, and Wieland 2017). The databases chosen were Scopus, EBSCO, and ABI/INFORM. Scopus has the largest database of peer-reviewed literature (Merli, Preziosi, and Acampora 2018) and is where most scholars search for academic papers. EBSCO and ABI/INFORM are comprehensive business and management databases.

After selecting the databases, the next step is to develop inclusion, exclusion and quality assessment criteria. The inclusion criteria are: academic journals, peer reviewed, in the English language, no limit time, limited to field of studies in business and management, contribute to answering the LRQs, title screening word “circular”, keyword “circular economy”, “closed loop” and title, and abstract words “sustainability” and “Circular Economy”. The word “sustainability” is included as few authors link sustainability and CE. Table 9 shows the inclusion and exclusion criteria in this review.

Table 9 The inclusion and exclusion criteria

Inclusion	Exclusion
Academic articles	Technical and biological terms
Peer reviewed	Non-English language
English language	Book chapter
No time range	Animals
Field of studies	Dairy
Contribute to answer the LRQs	Feedstock
Title screening word “circular”	Ornamental plants
Keyword “circular economy”, “closed loop”	Flowers
Title and abstract “Circular Economy”, “Sustainability”	
Vegetables and Fruits	

Search Strings

Table 10 shows the search strings used for this systematic literature review from three databases, Scopus, EBSCO, and ABI/INFORM resulting in a total of 1446, together with the search date.

Table 10 Database, search string, and number of papers

Database	Search string	No of papers	Date search
Scopus	("Circular Economy" OR "Circularity" OR "Closed loop" OR "Clos* loop") AND ("Agri-food" OR "Agri food" OR "fruit*" OR "Vegetable*" OR "perishable") AND ("Supply chain" OR "Supply network" OR "Supply chain management") AND (“Natural resource based view” OR “NRBV”)) AND (LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE,"j"))	840	27/10/2019
EBSCO	"circular economy" OR "circularity" OR "closed loop" OR "clos* loop") AND ("Agri-food" OR "Agri food" OR "fruit*" OR "vegetable*" OR "perishable") AND ("supply chain" OR " supply network" OR "supply chain management") AND (“Natural resource based view” OR “NRBV”)	46	
ABI/INFORM	(("Circular Economy" OR "Circularity" OR "Clos* loop") AND ("Agri-food" OR "Agri food" OR "fruit*" OR "Vegetable*" OR "perishable") AND ("Supply chain" OR "Supply network" OR "Supply chain management") AND “Natural resourced based view” OR “NRBV”)) AND (bdl(10000008) AND at.exact (“Article”) AND stype.exact (“Scholarly Journals”) AND la.exact (“ENG”) AND PEER(yes))	560	
	Total	1446	

The total number of papers obtained from Scopus was 840, from EBSCO there were 46, whereas the papers that were retrieved from ABI/INFORM resulted in a total of 560. The results from the three databases totalled 1446 papers. These were then exported to an Excel worksheet that contained the following information: titles, authors, years, abstracts, authors' keywords, journal titles, DOI, URL link, and source of database. The following screening process was to remove duplicate articles using auto duplication in Excel and perform manual duplicates, which resulted in a total of 470. This was followed by the next phase, which was screening in Excel using a formula search for the key terms in titles, abstracts, and authors' keywords, such as "circular" and "agri food" in abstracts. Figure 8 shows the screening process. The next step continued with the manual filtering of titles and abstracts, leaving 65 papers to be analysed by reading the full text of the papers. During the process of compiling this thesis, there were seven new papers published in 2021, which were used as reference, increasing the total to 72 papers analysed. Of the seven papers, one is a review paper that observes the state of the art of CE adoption in overcoming FLW, while the other 6 papers answer the LRQs, particularly the barriers faced by SMEs, in developing countries or both developed and developing countries. By understanding the current research and barriers, it is hoped that this thesis will be more relevant and provide more solutions through presenting various findings and ideas in this thesis.

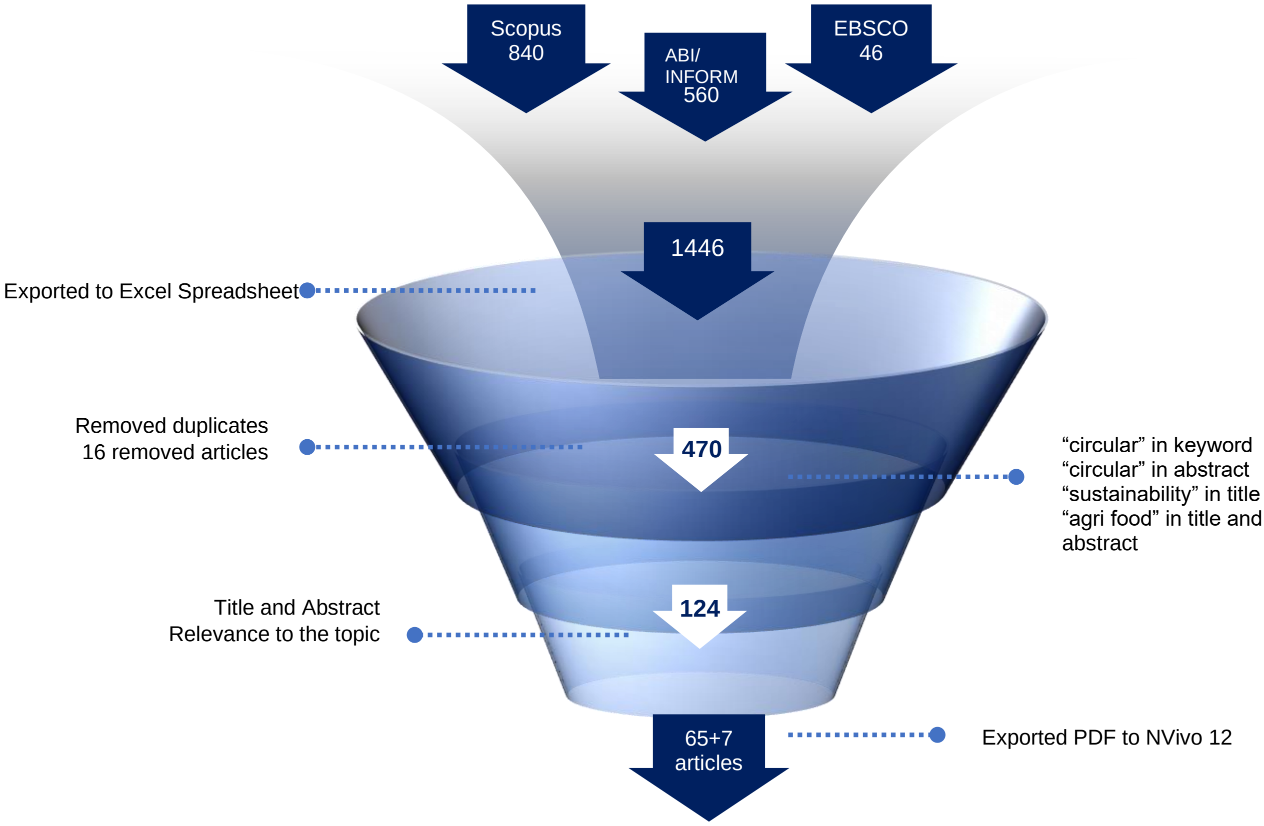

Figure 8 The screening process

3.4 Descriptive analysis

A descriptive analysis summarises the basic features of the data in a study to answer the questions who, what, where, when, and to what extent. The goals are to identify and describe trends and variation within the data obtained (Susanna et al. 2017). This section describes the distribution of papers across the journal titles, time range, and authors. To obtain as many papers as possible, this review does not limit the time range. The list of journals and number of papers is depicted in Table 11.

Table 11 The list of journals and number of papers

Journal	Number of paper(s)
Business Strategy and the Environment	4
Computers in Industry	1
Ecological Economics	1
Energies	1
Environmental Science and Health	1
European Journal of Sustainable Development	1
Green and Sustainable Chemistry	1
International Journal of Production Economics	1
International Journal of Production Research	1
Journal of Business Strategy and Development	1
Journal of Cleaner Production	17
Journal of Enterprise Information Management	2
Journal of Industrial Ecology	2
Land	1
Management Decision	3
Management of Environmental Quality	1
New Biotechnology	1
Omega	1
Packaging Technology Science	1
Procedia CIRP	1
Production Planning and Control	3
Recent Patents on Food, Nutrition and Agriculture	1
Resources, Conservation and Recycling	3
Science of the Total Environment Journal	3
Supply Chain Management: An International Journal	2
Sustainability	10
The International Journal of Logistics Management	2
Waste Management	2
Waste Management and Research	2
Waste Management and the Environment	1

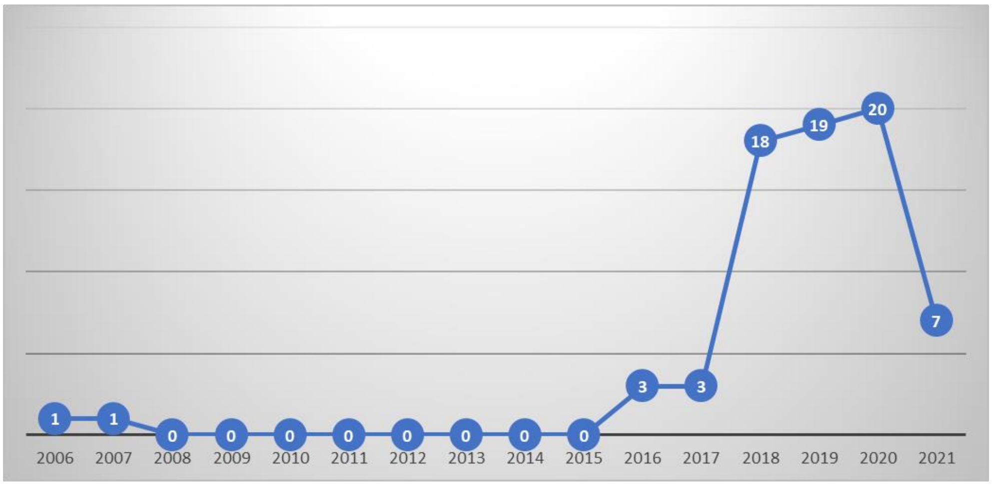

Figure 9 Number of papers and year of publications

A paucity of research is seen for eight years from 2008, where no relevant papers are released at all for almost a decade. Interest in research on the CE re-started in 2016, where a more rapid increase in the number of papers continued from 2018 to 2020, with the highest number of publications of 20 papers in 2020. Correlations in these papers argue the importance of environmental issues and the growing population that has enlarged the prominence and urgency of the CE. This thesis seeks the latest publications to discover the current state of the art. Therefore, this thesis adds seven new papers manually that are considered still relevant. Thus, the decline seen in Figure 9 from 2020 to 2021 does not reflect a decline in academic interest in the CE; perhaps piquing even more attention because CE is still a trending topic.

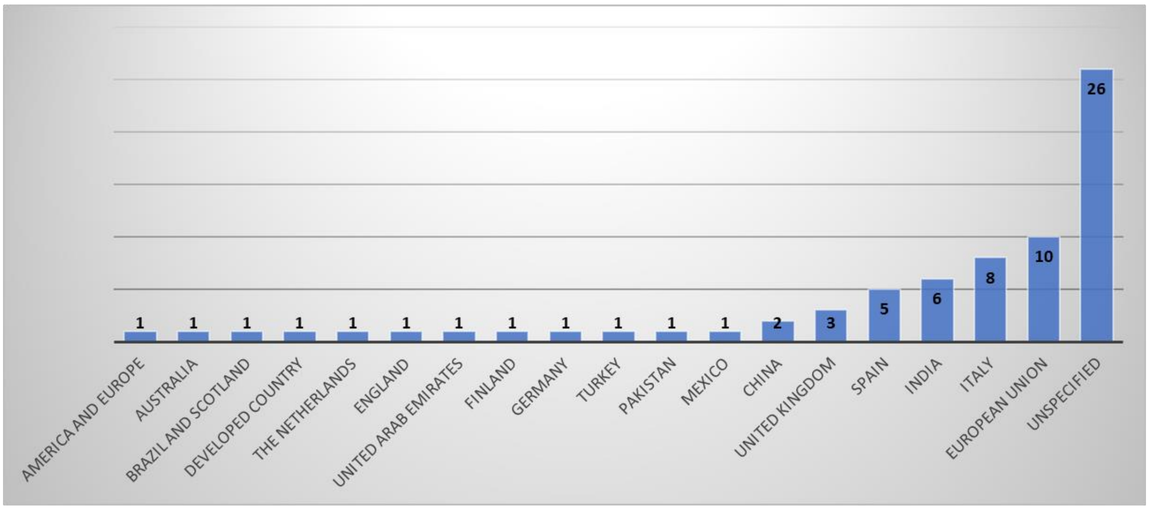

Figure 10 Number of papers and locations of studies

The review identified the geographical countries where studies took place, as described in Figure 10. Interestingly, the review comprised mostly papers with unspecified locations of study, taking up to 40% of the total number of papers used. This number is followed by the European Union, Italy, and India.

To obtain a deeper analysis of the literature, the author uses qualitative data analysis software NVivo 1.3 that is currently prevalent in academia. “The code is a way of labelling certain aspects of the data by sorting them into distinct categories” (Walsh 2003: 253–254). The coding set used a-priori codes following the literature review questions. However, since the purpose of coding is to classify the papers based on the contribution to answer the LRQs developed before the data collection, the codes are based on the LRQs. The key codes are definition, principles, outcomes, and barriers or could be considered as themes based on the thematic analysis.

3.5 Understanding Circular Economy in the agri-food industry

Based on the literature, each study’s explanation of the CE concept varies depending on the focuses and priorities raised according to the scope of the problems faced and the scientific point of view taken. In spite of this, all the papers obtained mentioned the EMF definition as a source of literature, in which the CE is an industrial system found on restorative and regenerative design principles that significantly enrich the narrative of supply chain sustainability by extending the functionality and value of resources and components, making it far more sustainable than the dominant linear economic model (make-use-dispose) (EMF 2015). Although the CE is still considered grey literature, spreading the meaning of CE remains crucial. This can be observed from the study conducted by Sehnem et al. (2019b); an article in the literature that attempts to explain the meaning of CE, which overlaps with other concepts such as cradle to cradle, industrial symbiosis or the closed-loop concept.

The CE concept is also described as a reverse logistics activity. This is an activity that involves the backflow of material, information, human resources, and finance among various stakeholders, thereby including a set of strategies to extend resource life, extract added value, and reduce value destruction (Blomsma and Brennan 2017, Kazancoglu et al. 2021, Maina, Kachrimanidou, and Koutinas 2017). Ripanti and Tjahjono (2019) further elaborated that the CE is a balanced system concept comprised of activities to make products from raw materials and vice versa through the stages of collection, maintenance, redistribution or cascading, which encompass economic, ecological, social, and technological aspects.

The term CE embedded in the supply chain is frequently used interchangeably with the term circular supply chain or CSC. An extension of the CSC is integrating unified thinking into the supply chain, which enables organisations to use resources efficiently, generate increased value for customers, and manage waste (Farooque et al. 2019, Mangla et al. 2018, Vlajic, Mijailovic, and Bogdanova 2018). Perhaps, the most researched areas concerning CE, such as downstream recovery and restructuring of logistics networks in the theme of reuse, recycle, remanufacture, and return in supply chains, have a positive impact on the firm's financial flows, although this also served as a challenge for each firm as it required substantial time and effort (Bressanelli, Perona, and Saccani 2019, Meherishi, Narayana, and Ranjani 2019). Lüdeke-Freund, Gold, and Bocken (2018) and Nosratabadi et al. (2019) evaluated the effects of CE on business models in supply chains and concurred that a business model backed by a CE increases its potential value by narrowing, slowing, and closing supply chain flows. This is because resources are maintained in cycles intending to increase the economy.

The EMF states that the CE is divided into two material flows; the technical material flow and the biological material flow. A CE related to biological matter is in contact with the concept of bioeconomics. D'Amato et al. (2017) and Istudor and Suciu (2020) found that bioeconomics and CE are concerned with “mobilising resources and increasing their productivity through recycling and process optimisation (CE), and adapting the use of renewable resources (bioeconomy).” Istudor and Suciu (2020) explained that while a CE includes economic, environmental, and social objectives, bioeconomics is more concerned with resources, biosecurity, and rural policies. Furthermore, their paper emphasises why food retail was chosen as a focus as it held significant influence on the supply chain, implying that efforts to implement a CE and bioeconomy in retail can generate a considerable impact. This is notably in line with the directives of the European Commission, which emphasises environmental standardisation in European firms.

A CE in the biological cycle is based on a number of issues that can affect the form of the alternative solutions given; these challenges include limited natural resources, GHG emissions, and biological waste, in which the literature has either highlighted one issue or raised all three along with other complications that these issues may entail (Del Borghi, Moreschi, and Gallo 2020, Maaß and Grundmann 2018, Rizos et al. 2016, Farooque et al. 2019, Homrich et al. 2018). Leaving the issue of limited natural resources unresolved will impact the wider environment, such as increasing greenhouse gas emissions, which were found to be an issue in driving the implementation of the CE (Palmieri et al. 2020, Yazdani, Gonzalez, and Chatterjee 2019). The use of natural resources for human purposes will also eventually produce waste. Additionally, the problem of waste was mentioned in numerous literatures to justify the need for in-depth research on the CE concept (Giudice et al. 2020, Krishnan et al. 2020, Ruiz-Penalver and Rodríguez 2019, Winkler and Kaluza 2006, Blomsma and Brennan 2017). Particularly in the agri-food sector, the emergence of a CE can be an alternative solution to the problem of FLW because it appears along the supply chain from upstream to downstream. As Ruiz-Penalver, Rodriguez, and Camacho (2019) emphasised, waste management is a crucial aspect in implementing the CE. This is because waste is generated from both the upstream and downstream in the supply chain, with different waste characteristics at each stage, as they may have contrasting conditions. For instance, while using biodiesel appears to be more environmentally friendly than gasoline, it requires clearing forests to make way for agricultural land. Therefore, this study created a Waste Input Output (WIO) model to analyse direct (upstream) and indirect (downstream) waste from a commodity.

The following are examples of the application of a CE in the biological cycle, which focuses on overcoming food waste. Some papers have attempted to conduct specific research on the CE as a means of approaching the food waste problem by optimising the waste into other more valuable products (Hoehn et al. 2019, Cristóbal et al. 2018), as well as building strong collaboration between each unit in the supply chain to implement the CE (Dora 2020). More detailed examples, such as the study of Ricciardi et al. (2020), analysed the potential application of industrial agricultural residues from natural materials, particularly coconut, coffee, tubers, cotton, and rice, that have reached the end of their useful lives. Tedesco et al. (2019) applied the CE concept by processing fruit and vegetable waste (FVW) into high-value products such as vermicompost and a high-quality bioactive soil amendment using earthworms. In addition, earthworms can also be used as animal feed. By applying the CE concept, renewable carbon stocks derived from agricultural, or forestry biomass and organic wastes are converted into various end products and materials, including food, feed, bio-based chemicals, biopolymers, fuels, and bioenergy (Egea, Torrente, and Aguilar 2018, Maina, Kachrimanidou, and Koutinas 2017). The problem of waste, especially food waste, can be overcome by valorisation, which extracts the essential ingredients of the waste into other products of high value, such as enzymes, bioactive compounds, or raw materials for chemical substances (Corrado and Sala 2018, Teigiserova, Hamelin, and Thomsen 2020). Determining the chosen path to manage food waste, therefore, requires a clear definition, as well as dividing waste into proper hierarchies such as surplus food, food waste, and food loss (Teigiserova, Hamelin, and Thomsen 2020).

CE is a prevalent phenomenon that occurs in a range of sectors, including the agri-food sector. Jurgilevich et al. (Jurgilevich et al. 2016) state that the CE in the food system aims to use the material first as a product, then as reused/recycled materials, and eventually as energy. This means it strives to close the loop to as few cycles as possible and use a minimal amount of additional input, such as energy, in the process. The application of the CE in the agri-food supply chain in this thesis possesses its own characteristics despite the CE already being in the context of the supply chain, as the resources used are primarily derived from natural resources and aim to overcome existing FLW problems (Do et al. 2021, Corrado and Sala 2018). Teigiserova, Hamelin, and Thomsen (Teigiserova, Hamelin, and Thomsen 2020) agree to the idea that the CE's re-inventing framework approach for food waste helps generate business opportunities but cannot overlook the fact that several challenges regarding food waste prevention exist in the emerging circular bioeconomy. This includes a lack of agreement on food waste definitions, resulting in various measurement approaches and a high level of uncertainty in existing data, making extrapolation and comparison difficult.

The study continued by stating that while there is an agreement regarding the prevention and avoidance of disposal, there is ongoing debate and confusion regarding other end-of-life (EoL) treatments. Borrello et al. (Borrello et al. 2016), whose study entailed the bread supply chain, divided the FLW problem into before and after the distribution process in a linear supply chain. Krishnan et al. (Krishnan et al. 2020) also found similarities from an inefficient mango supply chain starting from the stage of cultivation through production, packaging, and distribution. Likewise, Esposito et al. (Esposito et al. 2020) highlighted the fact that there is a common, increasing awareness towards the idea that adopting a CE is able to overcome critical issues surrounding resource scarcity, food loss, and the enormous amount of waste generated across the global supply chain. Apart from issues faced by the product itself, some studies established the impact of GHG emissions from the agri-food supply chain process as a problem that needs solving with the CE (Kazancoglu et al. 2021).

Several works of literature provide an overview of the role of the CE in dealing with these problems. A study by Corrado and Sala (Corrado and Sala 2018) divides FLW into avoidable and unavoidable waste. Avoidable waste refers to an agri-food product that humans can still consume, while unavoidable waste is a product that can no longer be consumed despite some products that may still be able to, but are classified as unavoidable regardless, such as apple or potato skins that are not feasible. The two types of waste, hence, utilise two different strategies. Avoidable waste can be overcome by prevention, which includes designing a supply chain that has the potential to generate and reprocess waste. Meanwhile, unavoidable waste can be handled by valorising energy and material, with results separated into high-value products such as animal food, biomaterials, and biofuels. In addition, extracting regenerative separation agents, such as bio-surfactants, from non-food streams available in the food processing industry, through fermentation, can functionalise target proteins from plant sources for application, food, and nutraceuticals. This ultimately reduces the volume of existing waste (Sadhukhan et al. 2020). The division of the two types of waste is similar to Do et al.'s (2021) study, which divides the handling of FLW problems into prevention and managing waste.

Prevention efforts are associated with agri-food problems due to excess food, while management strategy deals with agri-food products that have become waste through valorisation. Based on this study, the prevention and management strategy of FLW must pay attention to aspects of supply, practice, logistics, market demand, assessment, and legislation. According to Kazancoglu et al. (2021) and Borrello et al. (2016), the application of the CE to overcome FLW is made by creating a reverse logistics design from the firm's previously linear system. With collaboration between stakeholders, the system will distort materials, such as product waste, packaging, and related resources for reuse or recycling purposes, ultimately impacting the prevention and treatment of FLW and, by doing so, lower GHG emissions.

The literature shows that The Life Cycle Assessment (LCA) is useful to assess environmental impacts. The study conducted by Colley et al. (2020) states that the LCA method can also be used to assess the impact of the approach at the core (midstream) stage, so appropriate procedures can be established to address waste or emissions generated in its business systems, such as the conversion of tallow to biodiesel and use of biomass for electrical and thermal energy. However, the study found that the current CE model is not designed for the complexity of the agri-food supply chain, thus requiring a more accommodative CE model, especially in terms of integrating different stages of the supply chain to ensure successful adoption of a closed-loop agri-food system (Esposito et al. 2020). Furthermore, coupled with the increasing population and rising demand for this industry, which has the potential to absorb more natural resources and generate waste and emissions, every firm needs to take advantage of driving factors and overcome the inhibiting factors to be able to implement the CE as soon as possible (Mehmood et al. 2021, Kazancoglu et al. 2021).

3.6 The principles of Circular Economy in the agri-food supply chain

Based on the literature, each researcher adheres to certain principles in implementing a CE. The EMF (2013b), a frequently used source, describes the principles of CE as minimising the use of virgin resources, maximising usage of resources to their highest utilities, and mitigating harmful externalities to the biosphere or oceans. The principles of CE are not entirely different from other existing concepts, with several studies having explored similarities and differences between CE and the concept of sustainability (Geissdoerfer et al. 2018, Merli, Preziosi, and Acampora 2018). Geissdoerfer et al. (2018) conclude that CE is a regenerative system that concerns resources, waste, emissions, and energy leakage. On the other hand, sustainability is a balanced integration of economic, social, and environmental goals to benefit present and future generations (World Commission on Environment and Development 1988).

Existing CE approaches were analysed to identify the following common themes: stock optimisation, eco-efficiency and effectiveness, waste reduction, and the 4Rs. In contrast, distinctions have been identified between the approaches, which may occur due to the CE's cycling extent (the tightness of the loop within a value chain) and scope (from a substance to an economic sector) (Kalmykova, Sadagopan, and Rosado 2018). One example can be observed from the recently published British Standards Framework for CE (BSI 2017), one of the many initiatives aiming to improve CE implementation across various sectors. Numerous businesses, universities, and government agencies collaborated on the development of this practical implementation guide, based on six key principles: system thinking; innovation; stewardship; collaboration; value optimisation; and transparency (BSI 2017), with particular emphasis on the transition from an antiquated and polluting linear economy to an innovative and sustainable CE (Homrich et al. 2018). Recent development in CE policy is summarised in two Ellen MacArthur Foundation reports. The first report, “Growth within: a circular economy vision for a competitive Europe” (EMF 2015), introduced the ReSOLVE framework, which is based on six business actions for businesses and countries interested in pursuing a Circular Economy transition: Regenerating, Sharing, Optimisation, Looping, Virtualisation, and Exchange. The second report, “Delivering the circular economy: a toolkit for policymakers” (Ellen Macarthur Foundation; McKinsey & Company 2015), laid out a step-by-step methodology for policymakers to use to accelerate the transition to a CE.

This thesis compiled the literature that implemented a CE and analysed what is required, notably in the agri-food sector. First, in a firm, the implementation of a CE will not occur without the awareness of the stakeholder. As such, every stakeholder, such as managers, must be aware of various environmental problems that threaten the existence of their business and then raise the need for efforts to overcome these problems (Dubey et al. 2019). Environmental consciousness is an essential principle because, with stakeholder awareness, various actions that seek to reduce negative environmental impacts can be more easily implemented (Ripanti and Tjahjono 2019). For instance, farmer awareness is vital in the upstream to establish proper cultivation, harvest, and post-harvest practices (Sharma et al. 2019). Hence, it is important for managers to provide training and skills development as a means of initiating a CE that is ecologically, economically, and socially beneficial in the future. Firms also need to increase consumer awareness at the downstream stage in order to influence consumer behaviour and deliver products that best suit their needs (Borrello et al. 2020). Several terms have been used to describe consumers’ concern for the environment, including going green, eco-conscious, sustainable, responsible, and pro-environmental behaviour (Kumar and Polonsky 2017). Without consciousness from consumers, firms will find it challenging to create environmental-based products, which serves as unfavourable in implementing a CE.

Second, findings from the literature indicate that to implement a CE, firms must be able to design products in such a way that will create a closed-loop system in their business. In other words, this principle emphasises preventing waste even before starting a business system (Kalmykova, Sadagopan, and Rosado 2018, Ripanti and Tjahjono 2019). Therefore, CE in the agri-food sector requires a complete rethink of food product design, packaging, and supply chain processes (Jabbour et al. 2019), in which waste generation must be eliminated at all stages of the supply chain, including agricultural production, post-harvest handling and storage, processing, distribution, and consumption (Farooque, Zhang, and Liu 2019). As such, firms can make appropriate product designs by cutting supply chain paths that were previously considered too long and mitigating paths that have the potential to generate waste. This is also supported by Jurgilevich et al. (2016), whose research found that the use of smart farming and the movement of farmers and consumers can reduce waste. A reason for this is a direct relationship between farmers and consumers, which reduces packaging, increases product freshness, and reduces time, effort, and transportation costs. Consequently, in order to design a production system such as those mentioned previously, it is also necessary to have information about lines that have the potential to produce waste. Moreover, information about production and FLW in the supply chain must be recorded appropriately (Del Borghi, Moreschi, and Gallo 2020, Corrado and Sala 2018). This information can be leveraged through big data to facilitate diverse decision making that can aid product design, hence enabling continuous improvement of the product life cycle (Jabbour et al. 2019). Research conducted by Belaud et al. (Belaud et al. 2019) integrated industry 4.0 into the agri-food supply chain to address food waste by combining big data and sustainable assessment. While this shows that big data technologies can be applied to a CE, it is relatively difficult to manage them with common tools due to their high volume, speed, and variety (De Mauro, Greco, and Grimaldi 2016, Hampton et al. 2013, Giudice et al. 2020). Complete data, on the other hand, will make it easier for firms to implement various appropriate policies, in which the right and consistent policies will result in healthy corporate culture. Therefore, the role of managers is needed to implement such policies and spread understanding, accompanied by conducting training for their employees as a form of their commitment to create product design as well as eliminate waste as part of CE implementation (Centobelli et al. 2020, Sehnem et al. 2019a).

Third, firms that follow the CE principle will maximise the value of their product by extending its life and reducing the damage that can potentially diminish its value (Blomsma and Brennan 2017, Do et al. 2021). This principle requires products to maintain their value for as long as possible in the supply chain (Ripanti and Tjahjono 2019). Maintaining value can begin during the production stage, continue through the distribution stage, and reach the final stage before being accepted by consumers. At the production stage, research by Yazdani, Gonzalez, and

Chatterjee (2019) exhibit an appropriate example of maintaining agricultural product value by trying to find the cause of the risks of flooding to determine the policies needed for the production stage to be successful. Krishnan et al.’s (2020) research on the mango fruit supply chain advises implementing organic farming, establishing a network of stakeholders to optimise distribution channels, and developing suitable packaging to ensure that each supply chain contributes to maintaining product value. Optimising supply chain systems, particularly for green products, can also be accomplished by maintaining product value while still trying to deliver products on time (Kazancoglu, Kazancoglu, and Sagnak 2018). During the distribution process, the role of the packaging is vital as it functions to reduce any damage to the product (Clark, Trimingham, and Storer 2019). Once the product arrives at the retailer, it will then maintain its value by maximising consumer sales. This means that the faster and the more products sold, the higher the quality consumers receive (Krishnan et al. 2020). Thus, in order to apply this CE principle, it is necessary for firms to make promotional efforts to increase public awareness of agricultural products (Kazancoglu, Kazancoglu, and Sagnak 2018).

Fourth, the literature shows that in the agri-food industry, firms must establish systems that minimise residue. This is because a significant amount of residue is harmful to the surrounding environment, and high residue levels will impair production yields, despite being generated along with the product itself when the system is run in the supply chain. Do et al. (2021) describe this as the pure circle principle, in which firms are required to produce biologically based products rather than fossil-based products to avoid polluting the environment. This principle emphasises the importance of protecting natural resources from various substances or materials that harm the environment (Ripanti and Tjahjono 2019). By applying CE, hazardous substances can instead be used in other products, or products can be redesigned to minimise leakage of substances in the system as much as possible (Krishnan et al. 2020). As such, firms can take advantage of various technologies to reduce leakage and toxic chemicals into the environment. These technologies are mentioned by the research conducted by Hoehn et al. (2019), namely the use of anaerobic digestion and composting as bioenergy technology, and the study of Genovese et al. (2017), who explored the production of biodiesel through applying CE principles that, in turn, generate lower emissions compared to following the long-established linear method. The technologies are considered capable of recovering methane gas and hydrogen gas, which can pollute the environment if released into the air. In addition, Tedesco et al. (2019) describe how vermicomposting and freeze-drying technology can be used to treat food waste, implying that using such technology can help reduce waste and provide suggestions for developing technology that uses renewable energy.

Fifth, as with any economic concept, firms that implement a CE should also aim to maximise their financial returns. This principle focuses on efforts to optimise the value of a product or resource by various activities such as recycling, remanufacturing or reusing in the biological life cycle (Vlajic, Mijailovic, and Bogdanova 2018). Optimising product value can also be accomplished by prioritising sales and product distribution in markets that can receive products at their highest prices (Cristóbal et al. 2018, Mehmood et al. 2021, Ripanti and Tjahjono 2019). In addition to placing products in the right market, product development to obtain value-added products can also be carried out to maximise financial benefits. This is seen in Tedesco et al.'s (2019) research, where food can be produced from earthworms processing food waste. Other product developments include processing waste from the meat supply chain into biodiesel (Colley et al. 2020) or utilising FLW such as meat to be processed into biogas using anaerobic digestion (AD) (Cristóbal et al. 2018, Hoehn et al. 2019). Moreover, Palmieri et al. (2020) state that agricultural waste can be converted into a source of electricity generation. Likewise, waste utilisation can also be applied for human purposes through advanced technology such as integrated biorefinery (Egea, Torrente, and Aguilar 2018, Sadhukhan et al. 2020). These studies utilised appropriate examples of implementing the principles by converting FLW into high-value products.

Sixth, in creating a closed-loop system, firms in the agri-food supply chain must design a biological material in several product stages, so the product can be reused numerous times through maximising its value. This principle was named by Do et al. (2021) as the cascading principle, with the principle of maximising biological product following the biomass value pyramid, rather than directly processing for low-value energy generation. While financial value is required for the profitability of any value recovery process in the supply chain, it does not fully support the creation of circular flows in the supply chain due to the influence of other factors such as resource availability, integration and coordination, as well as volume and quality (Rahman and Subramanian 2012). As such, firms need to consider the economic value and the stakeholder involved before properly designing the circular flow.

Furthermore, the greater the residual value of the product, the more likely it is to be recovered through a higher value recovery process. On the other hand, reuse and remanufacturing loops often feed the primary market, with recycling loops feeding the alternative market. As cascading activities direct other products to a broader market than products that only use a linear economy, this principle influences competitive advantage (De Angelis, Howard, and Miemczyk 2018). The cascades principle can be implemented according to the product's characteristics and the business system that is being built. One example is Lüdeke-Freund, Gold, and Bocken's (2018) review, in an analysis of the shape of 26 CE business model

(CEBM) options in the literature, as well as a typology of six main patterns of CEBM; repair and maintenance; reuse and redistribution; repair and remanufacturing; recycling; cascading and repurposing; and organic raw materials business model. The cascades principle that exists in biological pathways, specifically to overcome FLW and food surplus, is explained in the research of Teigiserova, Hamelin, and Thomsen (2020), where the management of food waste starts from the process of prevention, redistribution, reaching to humans, used as animal feed, material recovery processes, nutrient recovery, energy recovery, and finally the disposal stage.

3.7 Outcome of Circular Economy in the agri-food supply chain

The agri-food sector will face new challenges in a future business environment where resource efficiency and innovative technologies, which reduce food loss and waste throughout the supply chain, offer opportunities to accelerate the transition to more sustainable performance and an economically viable future. It is, therefore, critical to consider the combined environmental and socioeconomic benefits of reducing food loss and waste (Esposito et al. 2020).

In general, the presence of CE applications is considered to have a positive impact on three main aspects, namely social, economic, and environmental (FAO 2021, Bressanelli, Perona, and Saccani 2019, Geissdoerfer et al. 2018, Istudor and Suciu 2020, Kazancoglu, Kazancoglu, and Sagnak 2018). Taghikah, Voinov, and Shukla (2019) state that impacts of CE tend to improve economic and social performance by increasing consumer awareness toward green consumption patterns. Nosrabadi et al. (2019) state the firm can meet social, environmental, and economic benefit by designing sustainable business model, included designing sustainable value proposition, sustainable value creation, sustainable value delivering, and generating sustainable partnership networks. Slightly in contrast, however, Maaß and Grundmann (2018) assert that developing a wastewater management structure on agricultural land benefits the economy and the environment.

With the implementation of a CE in the agri-food supply chain, activities are carried out to reduce waste through a variety of measurements and collaborations (Esposito et al. 2020, FAO 2021, Kazancoglu et al. 2021). Managing waste generated from food can be done by establishing policies, particularly environmental policies that lead to CE implementation (Sharma et al. 2019). Research by Garske et al. (2020) recommends a policy that increases food prices and taxes, especially food that requires plenty of resources and inflicts harm to the environment. As the result of this policy reduces the amount of waste, negative impacts also diminish. The research of Jurgilevich et al. (2016) looks at various problems that arise in the food system and provides a range of alternative solutions to reduce food waste. Among these are supporting local agriculture, promoting sustainable consumption habits, and closing material loops at every possible stage. Several papers demonstrate how to convert FLW waste materials into other, more valuable products such as biorefinery (Kalmykova, Sadagopan, and Rosado 2018, Sadhukhan et al. 2020). Similarly, Hoehn et al.'s (2019) research explores the use of food waste for energy sources such as biogas. Furthermore, waste tracking, value-added processing, donating and converting waste into animal feed are also strategies found to lessen waste in each supply chain (Cristóbal et al. 2018).

Corrado and Sala (2018) and Del Borghi, Moreschi, and Gallo (2020) conducted research on food waste data collection, management, and estimation and valorisation of waste, which they found to be an applicable action to reduce food waste. This conveys the notion that measuring waste after it has been reduced is just as critical as the efforts undertaken to minimise waste. In addition, reductions can be started by grouping, as shown by the research of Teigiserova, Hamelin and Thomsen (2020), which advise that reducing FLW can be done using food hierarchies. Limiting waste by repurposing also applies to converting waste into raw materials for other processes and industries via industrial symbiosis, which will contribute to the transition from linear systems to a closed-loop (Wen and Meng 2015). Because industrial symbiosis also concerns the extension of product life, such as re-marketing and eco-efficiency, positive impacts are also generated through managing pollution reduction, energy consumption, and waste management efficiency (Chertow and Ehrenfeld 2012, Domenech et al. 2019, Gaustad et al. 2018).

As CE allows for supply that is often provided by virgin material to be replaced with alternative resources, such as waste, firms will be able to gain more stable pricing compared to prices offered by virgin material (Jurgilevich et al. 2016). Cascading materials across different supply chains creates additional revenue streams by selling secondary raw materials that can then be used to manufacture different products. This extends further downstream in the firm's supply chain, enabling companies to overcome price volatility from primary resources (De Angelis, Howard, and Miemczyk 2018). The CE's high position in the political agenda, particularly in Europe, agrees with this idea that economic growth can be achieved through the creation of new businesses and job opportunities, lowering material costs, reducing price volatility, and enhancing supply security, all while mitigating environmental pressures and impacts as outcomes of CE adoption (Del Borghi, Moreschi, and Gallo 2020).

In addition to stabilising the price of agri-food products, CE will also improve food security because the CE concept strives to secure food across the supply chain, including the production, distribution, and consumption stages. However, realising food security is not a simple endeavour due to the numerous variables that affect food safety (Irani and Sharif 2018). Directly for the upstream, this includes climate change, fluvial systems, and government policy factors that cause flood risk to agricultural land (Yazdani, Gonzalez, and Chatterjee 2019). Even so, according to Egea, Torrente, and Aguilar (2018), applying the CE principle, particularly in the biological cycle, will impact food security and economic development through bioenergy and bioproducts. This echoes the idea that the CE will encourage the development of knowledge and strengthen research applied to innovation, and realise a climate balance and public awareness, particularly in the production of primary needs for food security and nutritional quality (Barcaccia et al. 2020).

Another outcome demonstrated from adopting CE in the agri-food supply chain is that firms would benefit economically by gaining resilience in enforcing their economic stability. This is exemplified by the use of biorefinery systems and valorisation, which creates by-products with value and opens new markets in the community. Such objectives should be encouraged by the government to expedite the transition from a linear economy to a CE (Maina, Kachrimanidou, and Koutinas 2017). Additionally, Egea, Torrente, and Aguilar (2018) and Lüdeke-Freund, Gold, and Bocken (2018) highlight that the existence of new products from product diversification efforts as part of a CE would undoubtedly break the cycle of poverty and provide new employment opportunities. In terms of gaining profit for the firm, according to Giudice et al. (2020), managers must build added value in enterprise relationships, exploit big data, and redesign existing systems. Clark, Trimingham, and Storer (2019) add that survey participants believe that there are economic benefits from a CE through self-sufficiency in raw materials. This corresponds with newly recognised incentives for firms to implement a CE based on the potential of enhancing economic benefits (Hussain and Malik 2020), whereas previously identified CE motivations relate to supply chain risk minimisation and de-coupling economic and ecological development (Hofmann 2019). Moreover, non-linear business models based on remanufacturing and reusing promise benefits from lowering costs, thereby significantly increasing revenue, whilst reducing considerable environmental impacts (Linder and Williander 2017). For consumers, minimising food waste enables them to save or spend their money elsewhere (FAO 2021).

The process of implementing a CE ensures the preservation of virgin materials from nature by replacing raw materials with materials derived from waste (Mehmood et al. 2021). According to Hussain and Malik (Hussain and Malik 2020), firms could make efficient use of resources when the purpose of CE is effectively conveyed, which ultimately benefits the economy and the environment as firms move to implement the system. One result seen in agricultural land is leakage minimisation (Genovese et al. 2017). As the CE can be attained by “developing the domestic secondary supply of rare earth element", this can benefit society by advancing regional and national goals toward CE (Machacek et al. 2015). Likewise, the study of Kazancoglu, Kazancoglu, and Sagnak (2018) state that the presence of the CE will protect the environment, minimise consumption of resources, and improve corporate image by enhancing operational performance in the firm. Whereas Krishnan et al. (Krishnan et al. 2020), who conducted a study on the mango supply chain, reveal that preserving natural resources could be done by conditioning the soil, fertilising processes, and implementing organic farming. In addition, conducting certification or periodic evaluations such as GRI 301 to GRI 308 regarding standardising environmental-based business practices can also prolong natural resources (Istudor and Suciu 2020). Thus, the outcome of the CE will protect natural resources and enhance the regeneration process.

In relation to the environment, one outcome of implementing a CE is the reduction of carbon emissions. To assess firms' green business performance, environmental impacts are measured in terms of CO2, NOx, SO2, and particulate emissions. As the food industry continues to develop and increase CO2 emissions, studies on reducing GHG emissions grow more relevant than ever (Kazancoglu et al. 2021). This inclination is consistent with the findings of a previous study in the Almeria agro-industrial complex, which demonstrated a decrease in reliance on fossil fuels as a result of an attempt to implement a CE in its system (Egea, Torrente, and Aguilar 2018). Consequences of carbon emissions include eutrophication, depletion of mineral resources, depletion of the ozone layer, and occupation of agricultural land. By applying a CE through the LCA, efforts to reduce carbon emissions can then be carried out (Colley et al. 2020). The application of a CE also supports the reduction of carbon emissions by valorising the amount of natural residue from the agro-industrial goods processing industry (Ricciardi et al. 2020).

Firms that operate by implementing the CE principle will gain a competitive advantage, as the literature review reveals broad agreement regarding the linear production's economic potential as a source of competitive advantage through resource optimisation in manufacturing processes (Reike, Vermeulen, and Witjes 2018). According to the EMF, during the transition to a CE, primary material consumption in the Europe Union (EU) could fall significantly in the food, construction, and mobility industries, by as much as 32% by 2030 and 53% by 2050 (Ellen Macarthur Foundation; McKinsey & Company 2015). This would benefit the competitiveness of EU manufacturing firms, given that materials and components account for 40%-60% of total costs and that Europe is heavily reliant on imports of resources, such as fossil fuels and metals, amounting to approximately 60% of total costs. Along with economic and business opportunities, the CE is argued to be capable of fostering prosperity without further depleting natural capital (Schulte 2013, CISL 2015, Gregson et al. 2015, Murray, Skene, and Haynes 2017).

3.8 Barriers in adoption of Circular Economy

Implementing a CE is certainly not as straightforward as it seems since firms must overcome numerous, varying barriers to realise the CE. Earlier research on the CE concept and implementation in China (Geng and Doberstein 2008, Geng et al. 2009, Su et al. 2013) discuss some macro-level barriers. However, the majority of these conceptual studies take a broad view that may not be entirely applicable in the supply chain (micro-level) context. Among the few studies on the CE from a supply chain perspective, Farooque, Zhang, and Liu (2019), Govindan and Hasanagic (2018), and Tura et al. (2019) use systematic literature reviews and case studies, respectively, to develop a multi-perspective CE framework that includes drivers, barriers, and practices. Although they did not perform systematic prioritisation or analysis of interrelationships among the identified factors, one study made by Sharma et al. (2019) explored the relationship between barriers in implementing CE, stating that the lack of technology and technique can in fact influence other barriers.

From the literature analysed, several barriers can be grouped. The first barrier identified is the inconsistent definitions of food waste that inhibits the development of coherent regulatory metrics for quantification (accounting) and keeping global losses to mere estimations (Parfitt, Barthel, and MacNaughton 2010). In addition, existing data have a high degree of uncertainty (Corrado and Sala 2018) and have differing measurement scopes, making extrapolation and comparison extremely difficult (Teigiserova, Hamelin, and Thomsen 2020). This insufficiency can result in an inappropriate categorisation of food waste, which can be linked to the waste hierarchy that currently does not adequately differentiate terminologies associated with sustainable management. Terms such as "food loss" and "food surplus," "recycling" and "reuse," and "recycling" and "recovery" are used interchangeably throughout the hierarchy (UNEP 2015, Bernstad Saraiva Schott et al. 2013).

The second barrier is the lack of clarity regarding the benefits of the CE (Ormazabal et al. 2018). Literature found that firms are hesitant to implement CE due to the perceived risk. The findings of Meherishi, Narayana, and Ranjani’s (2019) study indicate that the current transition to CE is entirely constrained by research efforts for downstream recovery and logistics networks, including a greater emphasis on fragmented supply chain segments that generate multiple positive and negative impacts. As a result, firms are reluctant to adopt CE-related policies. According to the contingency theory, businesses often shape their business environment by developing appropriate strategies to deal with the uncertainties of CE implementation, and then rely on the associated environmental and economic benefits (Geng et al. 2009). Nonetheless, if management continues to doubt the benefits of a CE, barriers will keep rising, especially when current processes and technologies continue to be profitable, in which the firm will prefer to maintain the existing business (Shi et al. 2008).

Another barrier is the lack of knowledge and skills about CE in the supply chain (Geng et al. 2009, Mehmood et al. 2021). Firms that struggle to obtain information and lack technical competence are caused by a lack of commitment and management capacity to develop the firm and resistance to change (Farooque, Zhang, and Liu 2019, Shi et al. 2008). In addition, insufficient information often occurs because of the unavailability of CE-compatible technology and the absence of firm best practices as performance indicators that can serve as role models for other firms (Geng and Doberstein 2008). This barrier is also faced by farmers at the upstream stage in the supply chain (Sharma et al. 2019). Kirchherr et al. (2018) found that cultural barriers, particularly hesitance on the existence of a CE, make a firm slow down or even thwart the transition to a CE. Sharma et al. (2021), who examined the prospects, barriers, and conditions of the transition to a CE in SMEs, revealed that managers' reluctance to understand and adopt a CE led them to maintain their linear economy. This problem of knowledge about the CE is often found in developing countries, particularly in developing SMEs (Cantú, Aguiñaga, and Scheel 2021, Mangla et al. 2018, Rizos et al. 2016). One reason for this is that SMEs wanting to adopt a CE find it challenging to find relevant information that can explain the CE in detail (Mura, Longo, and Zanni 2020).

The next barrier is financial constraints. It is generally recognised that firms' ability to adopt a CE is often hampered by their economic capabilities (Galvão et al. 2018, Cantú, Aguiñaga, and Scheel 2021, Genovese et al. 2017). Additionally, several fundamental obstacles to advance the CE transition are related to the frailty of the economic viability mechanisms (Genovese et al. 2017). Other impediments to CE integration into SCM include implications of high costs (Giunipero, Hooker, and Denslow 2012) and a lack of economies of scale associated with a CE. In developing countries, financial barriers are notably significant obstacles, particularly when investing in advanced technologies that are typically imported from well-developed countries (Ali et al. 2021, Bilal et al. 2020, Gedam et al. 2021, Kirchherr et al. 2018). Furthermore, Ormazabal et al. (2018), Rizos et al. (2016), and Scipioni, Russ, and Niccolini (2021), who observed CE barriers faced by SMEs, found that the lack of capital prevented firms from going “green”. Oftentimes, SMEs that have difficulty meeting financial needs are firms that are manipulated by market players and have insufficient alternative market references (London, Anupindi, and Sheth 2010). While the CE transition promises financial improvements, these challenges must still be faced, as adopting innovative technologies and enhancing enterprise capabilities are necessary steps (Gurtoo and Antony 2007, Borrello et al. 2016, Esposito et al. 2020, Mehmood et al. 2021). In spite of this, customers are still used to using old business products and services (Bressanelli, Perona, and Saccani 2019), so firms constrained by financial problems will be restricted from gaining any competitive advantage (Roscoe and Cousins 2015).

One barrier frequently encountered by firms attempting to implement a CE is the lack of interest from other firms to cooperate at the supply chain level (Rizos et al. 2016). As Farooque et al. (2019) draw on insights from the resource dependence theory stating that organisations are interdependent, firms' reluctance to collaborate exacerbates the disparity of fragmented and disjointed CE achievement indicators, creating clashing perceptions at all levels in supply chains (Ferasso et al. 2020, Schraven et al. 2019, Farooque, Zhang, and Liu 2019). Bressanelli, Perona, and Saccani (2019), who looked at the challenges of redesigning a supply chain according to a CE, discovered that it was difficult to find a suitable partner with whom to work. A similar predicament can be observed from the study conducted by Sharma et al. (2019), which found that while CE-based agricultural products would require a cold chain to maintain quality, it is challenging to implement due to the lack of infrastructure from each supply chain.

Barriers also occur when customers are reluctant and there is a lack interest in using environmentally based products (Magendans 2015), because firms trying to adopt a CE without market pressure will undoubtedly disrupt economic processes. Bilal et al. (2020) observed that a factor largely contributing to customers' disinterest is a general lack of public awareness of CE. This, therefore, aligns with De Angelis, Howard, and Miemczyk's (2018) study on the importance of changing the perception of product value in society. As current market desires are still interested in linear products, the transaction process for CE-based products is hindered (Kirchherr et al. 2018, Scipioni, Russ, and Niccolini 2021). In developed countries, the culture of using single-use items remains pervasive, as is the disposal of food and waste (Sadhukhan et al. 2020). Low public awareness is also evident in the way packaging is disposed of, where people are often confused when it comes to sorting, and they combine waste instead, which complicates the recycling process (Hahladakis and Iacovidou 2018).

Customers that are skeptical of CE-based products or services and have a limited ability to pay for these products also raise difficulties (Cantú, Aguiñaga, and Scheel 2021). Thus, firms seeking to alter public skepticism must be able to communicate a shared vision for the firm to continue to grow and have long-term competitiveness (Hart 1997). Various predictions of challenges from consumers that firms could encounter in 2025 are delivered by Clark, Trimingham, and Storer (2019): consumer education, changing shopping habits, increasing choice of shopping methods, and the ability to attract new customers to brands (increasing brand trust and loyalty). Interestingly, in a change of market needs, market cannibalisation will occur. A reason for this is that CE products will threaten the sale of other products, giving rise to the public's willingness to buy products during the transition to a CE (Bressanelli, Perona, and Saccani 2019). Regardless of the outcome, firms with a vision will certainly continue to redesign and improve their strategies to meet these hurdles (Hart 1995).

The last barrier identified is the insufficient support firms receive from the government. Coherent regulations related to the CE, particularly environmental-based regulations (Mangla et al. 2018), must be established by the government, as ambiguous regulations could impede firms further (Bressanelli, Perona, and Saccani 2019, Mura, Longo, and Zanni 2020). Such regulations will encourage clear product standardisation, allowing firms to benchmark their capabilities. Making government regulations also indirectly disseminates the CE concept to the public, increasing public awareness of the CE. Borrello et al. (2020) stated that one of the problems with the CE is regulatory barriers in applying new technologies. Therefore, it is crucial to stress the urgent need for a legislative push for a CE. Moreover, Istudor and Suciu (2020) conducted a study on the various implementations of CE in food retail in European countries, concluding that one of the challenges to CE was the variation in how CE was applied in each country due to the absence of official laws. A similar predicament is seen by Sharma et al.'s (2019) study that examined barriers in India and found that the lack of government support in regulations and incentives makes it difficult for farmers and firms to move towards a CE. Additionally, public institutions are unable to adequately provide support to firms, especially to SMEs (Bilal et al. 2020). Hence, in developing policies, it is also vital to pay attention to the circumstances surrounding the barriers faced, because different barriers will necessitate distinct strategies (Ormazabal et al. 2018).

3.9 Initial framework and propositions

While some may claim that conceptual and theoretical frameworks are interchangeable, Adom, Attah, and Ankrah (2016) highlighted that they exhibit distinct characteristics. A theoretical framework provides a general set of ideas within which the study belongs, based on the existing theories in the literature that have been validated by other researchers and are well developed, as it is explicitly used to test theories. The conceptual framework, however, refers to specific or narrower ideas of a researcher, which could be from the researcher's own constructed model to explain the relationship between the main variable and possibly the adaptation from established theory. This framework aims to develop a theory that would be useful for practitioners in the field (Adom, Attah, and Ankrah 2016).

A conceptual framework serves as a foundation and guide for research, establishing the researcher's academic position and the underlying factors influencing the researcher's propositions (Adom, Attah, and Ankrah 2016). A framework itself enhances the rigour of the research, thereby making the research findings acceptable within the theoretical constructs in the particular discipline and ensures generalisability. The relevant theory is chosen to underpin the knowledge base of the phenomenon investigated, and the framework is based on an existing theory related to the propositions or hypotheses of the study. Grant and Osanloo (2014) pointed out that the framework resembles a "blueprint" of a house which provides a grounded base for the literature review, methods, and analysis in the research. Selecting a theoretical framework is tightly aligned to four constructs: the problem, purpose, significance, and research questions. Jabareen (2009) argues that a conceptual framework creates an interpretative approach to social reality and places emphasis on understanding.

Building a conceptual framework, expressed graphically rather than in-text, will allow the interrelationship between the theories to be illustrated, as indicated by the arrows (Miles and Huberman 1994). As referred to in Grant and Osanloo's (2014) research on distinguishing theoretical and conceptual frameworks from their characteristics, the term conceptual framework will be used in this study. As such, this research will propose a framework based on the adaptation of established theories to explore the current phenomenon of a CE.

The proposed conceptual framework is depicted in Figure 11. This section discusses the study's initial framework, which was developed by combining the NRBV theory with CE to form a synthesis of the study literature. The thesis attempts to explain how this relationship can occur due to similarities in constructs between the concepts and phenomenon studied. A set of initial propositions is classified into four categories according to strategic capabilities, outcomes, and barriers:

Pollution prevention

From the literature collected, this thesis found a relationship between the company's ability to apply CE principles in the agri-food supply chain. However, there is no clear relationship between which capabilities affect certain CE principles. According to Dubey et al. (2019), every manager has a responsibility to spread environmental awareness to all company members. This awareness will encourage companies to redesign their business systems, resulting in a closed-loop system and preventing the production of waste (Kalmykova, Sadagopan, and Rosado 2018, Ripanti and Tjahjono 2019). Furthermore, product redesign efforts should maximise financial benefit (Cristóbal et al. 2018, Mehmood et al. 2021, Ripanti and Tjahjono 2019) because, without the incentive, companies will still prefer to use the old system

(Bressanelli, Perona, and Saccani 2019). The NRBV suggests that these measures align more with the firm's capability to prevent waste through various means compared to having to manage the waste generated (Hart 1995). Firms' awareness and commitment to improving the environment must also push them to acquire the capability to prevent waste by making product life cycles extend to even the hands of consumers (Ashby 2018). Some studies reveal that pollution prevention, which demonstrates continuous improvement, not only will manage waste, but also cut financial costs (Bhupendra and Sangle 2016, McDougall, Wagner, and MacBryde 2019). This, therefore, agrees with Hart (1995), as the prevention of waste facilitates lower costs whilst increasing the cash flow and profitability of the firm. As a result, the following propositions are built:

Proposition 1a: In the context of agri-food supply chains, firms that have continuous improvement will effectively adopt waste elimination endeavour.

Proposition 1b: In the context of agri-food supply chains, firms that have resource of continuous improvement enhance economic optimisation.

Proposition 1c: In the context of agri-food supply chains, firms that have resource continuous improvement establishment of the environmental consciousness.

Product stewardship

As observed in the literature, the CE principle of maximising product value across the supply chain can be carried out at various stages. These stages include product development, distribution, and when the product reaches the retailer stage (Kazancoglu, Kazancoglu, and Sagnak 2018, Krishnan et al. 2020, Yazdani, Gonzalez, and Chatterjee 2019). Based on the NRBV theory, to maintain the value of the product, collaboration from various stakeholders is needed (Mishra, Chiwenga, and Ali 2019). However, if the product's quality cannot be maintained, stakeholders would instead pursue a strategy of optimising the product's economic value by special handling and distributing into different supply chain channels (Do et al. 2021) to gain a competitive advantage for the company (De Angelis, Howard, and Miemczyk 2018). As suggested by the NRBV theory, accomplishing these activities requires firms' ability to exchange information and establish positive relationships (McDougall, Wagner, and MacBryde 2019). This was also conveyed by Rodrigues et al. (2021) that, in order to gain a competitive advantage and overcome food waste, companies must be able to cooperate with other companies and understand the needs of every other stakeholder. As such, the propositions are as follows:

Proposition 2a: In the context of agri-food supply chains, firms that have resource stakeholder integration will attain maximisation of retained value.

Proposition 2b: In the context of agri-food supply chains, firms that have resource of stakeholder integration enable the opportunity to optimise cascades endeavour and therefore exhibit economic optimisation.

Sustainable development

The literature concludes that companies that adhere to CE principles must be able to reduce pollution that will pose detrimental effects on the environment and return biological substances that have been used on the soil without any damage (Do et al. 2021, Ripanti and Tjahjono 2019). Multiple studies provide concrete examples to overcome this harmful pollution, such as producing compost and bioenergy to avoid air pollution (Hoehn et al. 2019), using low emission biodiesel (Genovese et al. 2017), or animal feed by utilising vermicompost and renewable energy (Tedesco et al. 2019). According to the capability strategy for the NRBV, efforts to reduce and eliminate carbon emissions or other pollution demand the company's capability to use advanced technology, which are parts of sustainable development (Cristina De Stefano, Montes-Sancho, and Busch 2016). This supports Hart's (1995) discoveries that sustainable development leads to a social-environmental purpose, in which companies explore shared vision resources by using environmentally friendly technologies.

Proposition 3: In the context of agri-food supply chains, firms that have resource of shared vision will enable leakage minimisation.

Outcomes

Various studies showed a range of results obtained when applying the CE principle. Kazancoglu, Kazancoglu, and Sagnak (2018) stated that by implementing a CE, companies will be able to gain economic, environmental, and social development. This can be observed in Maina, Kachrimanidou, and Koutinas' study (2017), where changing a linear economy to CE through the development of technology, processes' waste can increase industrial innovation, open up new market potential, and optimise natural resources. One outcome explored by Teigiserova, Hamelin, and Thomsen (2020) is the reduction of FLW by implementing the CE through formulating waste elimination strategies according to hierarchy. On the other hand, the application of CE principles, especially in the biological cycle, will provide food security and economic development by utilising bioproducts and bioenergy (Egea, Torrente, and Aguilar 2018). Colley et al. (2020) further added that applying a CE would lessen carbon emissions, agricultural land use, and depletion of the ozone layer. In addition, Jurgilevich et al. (2016) recognised that with efforts to reduce food waste, the CE will help to minimise waste, stabilise product prices, and reduce the loss of natural resources. Therefore, the proposed proposition reads:

Proposition 4: In the context of agri-food supply chains, applying CE principles will result in reduced FLW, increased food security, food price stability, economic resilience, preservation of natural resources, and reduction of greenhouse gas emissions and global warming.

Barriers

Although the concept of CE offers numerous results and benefits, the collected literature indicates that CE implementation involves facing quite a number of obstacles at differing levels of the supply chain. The most basic barrier commonly seen in adopting a CE is the occurrence of varying definitions (Parfitt, Barthel, and MacNaughton 2010) and the benefits it promises (Ormazabal et al. 2018). This means even companies already aware of CE must still strive to learn the strategies and skills needed to implement the CE (Mehmood et al. 2021). Another major problem concerns financial constraints, as companies will find it challenging to invest in appropriate technology (Bilal et al. 2020), particularly SMEs (Scipioni, Russ, and Niccolini 2021), and firms in developing countries (Ali et al. 2021). It is also important to note that barriers occur both internally and externally. This is marked by the lack of support from other companies (Rizos et al. 2016), followed by consumers who are not interested in products produced from a CE (Kirchherr et al. 2018), and the government's inability to assist the community as policymakers (Mura, Longo, and Zanni 2020). All of these issues impede the company from having sufficient capability to implement the CE principle effectively, resulting in the following proposed barriers:

Proposition 5: In the context of agri-food supply chains, the main barriers of CE adoption are lack of knowledge, and financial that hinder the transformation towards CE practices.

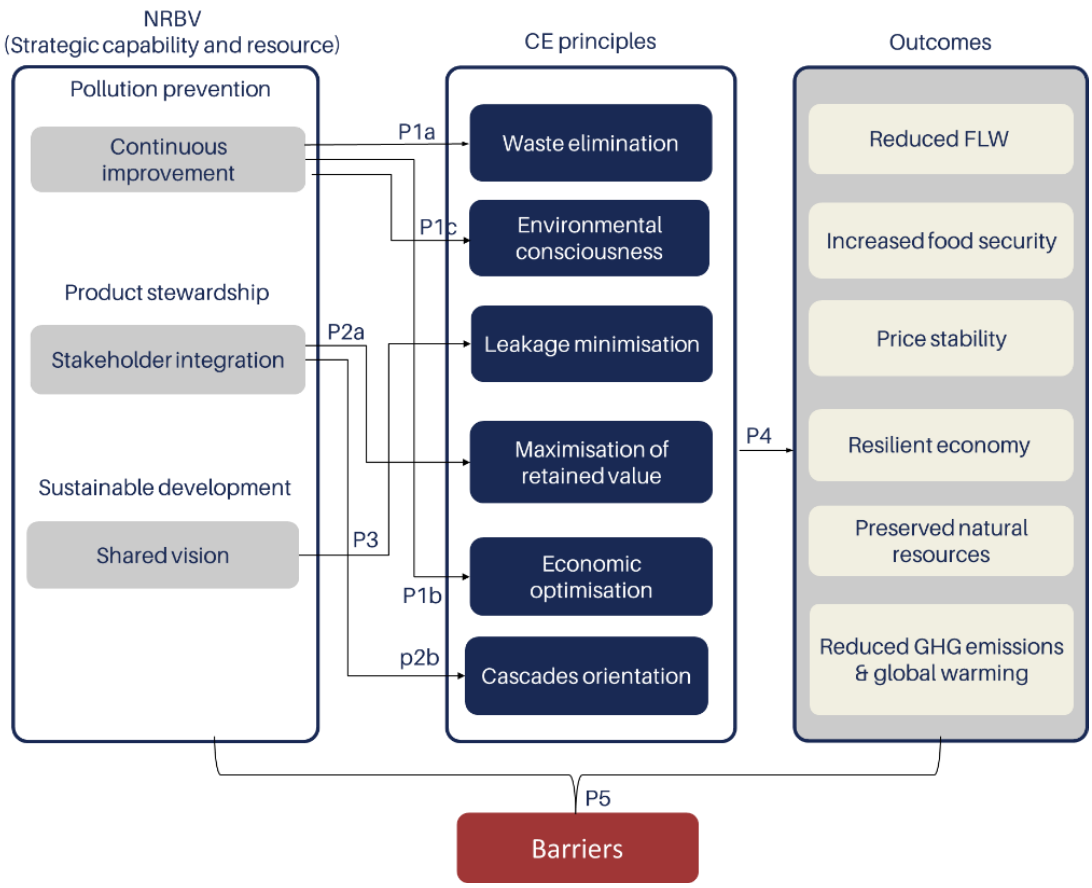

Figure 11 Conceptual framework – Circular Capability Framework

CHAPTER 4 RESEARCH METHODOLOGY

4.1 Research design

The qualitative multiple case study design is chosen to gain a deep insight of the phenomenon of CE. Through qualitative research, assumptions were built using theoretical frameworks; the data obtained explored a social problem in detailed view of participants, to identify the phenomena and how they are perceived by actors in a situation (Creswell and Poth 2018). The qualitative method was preferred as "the choice of method must be driven by the research question and nature of the phenomenon being investigated" (Borrego et al. 2009). As the objective is to investigate the phenomenon of CE in a particular industry, the agri-food supply chain, an appropriate way to gain understanding is by conducting a qualitative research method that has the exploratory character. Especially with regards to understanding the early stage of the concept (Frodermann 2018) and the need to consolidate definitions, principles, and practices (Merli, Preziosi, and Acampora 2018).

The case study research design follows theory elaboration of the case study, from which it is possible to gain deeper knowledge on the phenomenon of CE in the agri-food supply chain. Yin (2018) defines a case study as:

> "An empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." (Yin 2018: 15)

Another definition of the case study is from Simons (2009: 21): "an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy or institution, programme or system in a 'real life' context. It is research-based, inclusive of different methods and is evidence-led". The case study can be classified based on the time dimensions: (1) **Retrospective** case study that involves the collection of data relating to past phenomenon. (2) **Snapshot** studies where the case is in one particular period of time. Juxtaposition (the fact of two things close together side by side with contrasting effects). (3) **Diachronic** study that is similar to a longitudinal study over a long period of time. Therefore, this research uses the snapshot time dimension.

Based on the literature studies, CE is considered to be a new concept, particularly in the agri-food industry supply chain. The growing interest of CE research revolves around the practical implementation within the agriculture industry of processing waste, to be converted into nutrients and renewable resources. The literature suggests an agricultural complex as a solution to achieve close loop, as it allows converting agriculture waste into valuable resources such as biogas through the anaerobic digestion. Additionally, it provides an in-depth understanding of how CE has been implemented in the agri-food industry. Furthermore, a qualitative study allows flexibility within the process and adaptation to the research questions to some extent in order to obtain a robust result, as well as help formulate the propositions. Hence, qualitative research is a suitable choice for this study.

The research design of this thesis is depicted in Figure 12, with one arrow illustrating the flow of research processes, and a two-way arrow representing the interactions between them. This thesis adopts case research with the purpose of theory elaborating (Ketokivi and Choi 2014, Yin 2018). Fisher and Aguinis (2017) defines theory elaborating as “conceptualising and executing empirical research using preexisting conceptual model as a basis for developing new theoretical insight.” The advantages of the case study include potentially deriving new hypotheses, exploring complex interaction effects, and causal mechanisms (Easton 2010, Starman 2013).

Following the theory elaborating case research study design, this thesis employs a combined retroductive-abductive research strategy. Retroductive research focuses on the underlying mechanisms of a phenomenon (Blaikie 2007) whereas abductive research requires the researcher to switch back and forth between theory and empirical data (Ketokivi and Choi 2014) in order to generate plausible explanations for a phenomenon (Ketokivi 2006, Wynn and Williams 2012). This strategy ensures that the process of explaining the mechanisms of CE adoption in the agri-food supply chain is guided in this thesis by NRBV as a theoretical lens. Table 12 illustrates the research step and author references that guided this thesis.

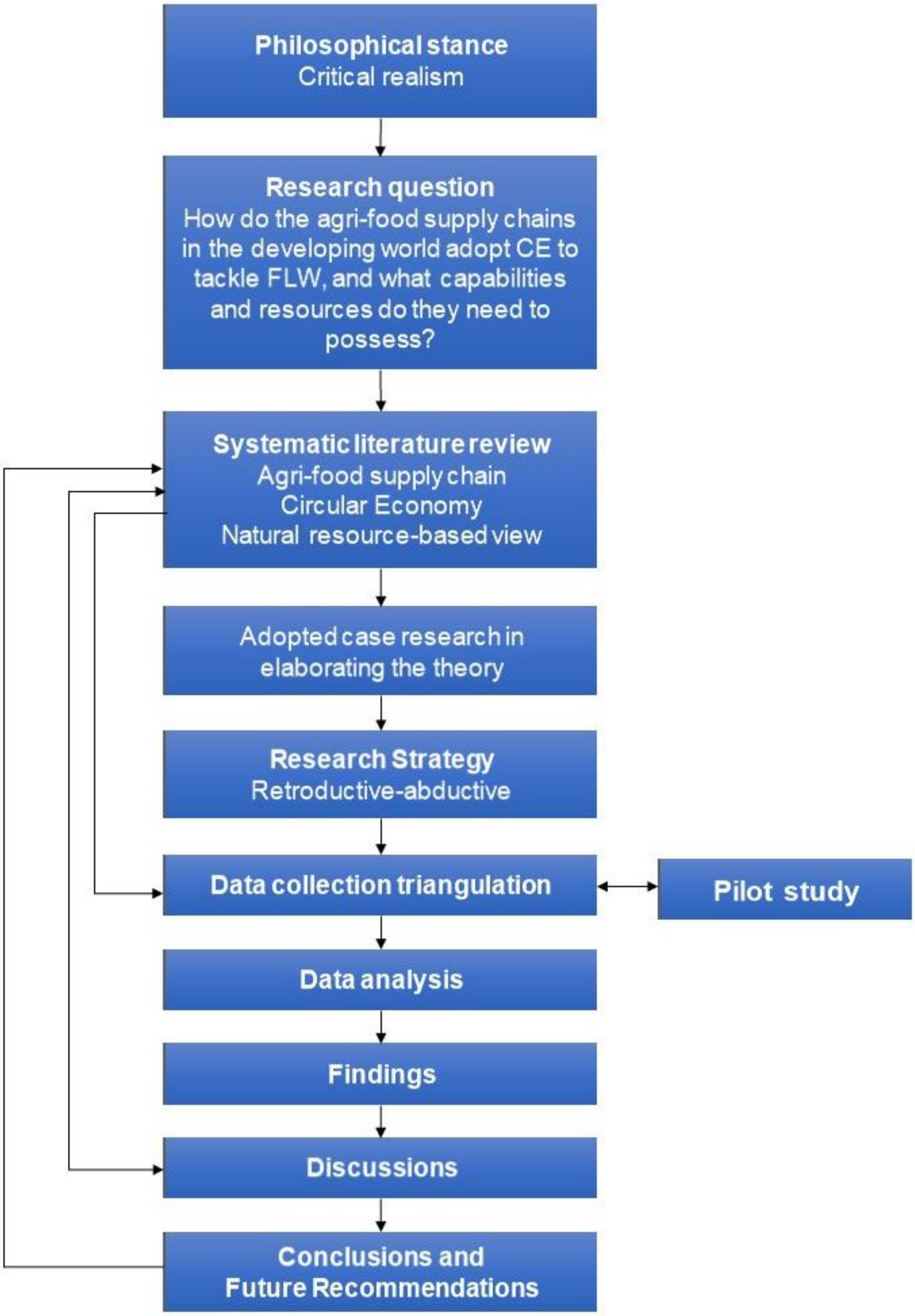

Figure 12 Research design of the thesis

Table 12 Research step with author references

Research step	Description	Author reference
Research philosophy	Critical realism to answer the question of how the strategic capabilities of NRBV affect the adoption of CE derive from systematic literature review to find the gap in the literature	Bhaskar (2016) Sayer (2000) Easton (2010) McAvoy and Butler (2018) Ackroyd and Fleetwood (2000)
Research question	Develop framework and propositions	Use theoretical lens NRBV With the main references Hart (Hart 1995) and Hart and Dowell (2011). CE principles literature Ripanti and Tjahjono (2019)
Research design	Qualitative study	Creswell and Poth (2018)
Case study	Case research for elaborating theory	Ketokivi and Choi (2014) Fisher and Aguinis (2017) Yin (2018)
Data collection	Semi-structure interview Company Visit Company website Obtain ethics Conducting a pilot study	Yin (2018) Building the interview guideline refer some papers McDougall, Wagner, MacBryde (2019); Mena et al. (2014)
Data analysis	Template analysis Within case and cross-case Developing template, QDAS NVivo 1.3	King (2012) King and Brooks (2017)

There are three categories of conducted research using case research: theory generation, theory testing, and theory elaboration (Ketokivi and Choi 2014). This thesis has a purpose of theory elaborating by studying the adoption of CE using the theory of NRBV as theoretical lens.

> “Theory elaboration focuses on the contextualized logic of a general theory. In this regard, its underlying logic is similar to theory testing. The primary difference is that the researcher does not seek to test this logic, but rather, to elaborate it. (Ketokivi and Choi 2014).”

Ketokivi and Choi (2014) outlined the assessment of case research to meet duality of criterion. The first condition should correspond with existing theory. Table 13 shows the features and rationales for case study design.

Table 13 The features and rationales for case study design

Case study features	The features met in this research	Rationales for adopting the case study
The case study is a detailed holistic empirical investigation that emphasises the uniqueness and situationally of the case and	Yes	A phenomenon of CE, which is still in early stages is investigated in the context of the agri-food supply chain

draws on a variety of data sources (Yin 2018).		
Theory elaboration (Ketokivi and Choi 2014). Develop propositions for further inquiry (Eisenhardt and Graebner 2007), Theory elaboration using the pre-existing conceptual framework as a basis for developing insights (Fisher and Aguinis 2017)	Yes	This research elaborates NRBV theory as a theoretical lens to understand the phenomenon of CE in the context of the agri-food supply chain and develop an initial framework namely circular capability model as the guidelines along with the propositions to be explained using a qualitative method.
The case study supports critical realism, consisting of one event bringing to another event (Easton 2010, Esfeld 2012)	Yes	The causal realism philosophical perspective underpinning this research. To explain the mechanism of strategic capabilities in NRBV affect the adoption of CE
The case study is able in to answer the "how" research question (Yin, 2018)	Yes	This research seeks to answer the question "*How do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?"*

4.2 Sample selection and description

The sample is selected based on non-probability critical sampling and recruitment, i.e., a purposive sample. The purposive sample is selected based on the characteristics of a population and the objective of the study. The objective of the study is to answer the research question: "How do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?" The supply chain actors focused on consists of growers, distributors, and modern retailers. The informants interviewed will be of management level to ensure that they are in a level of expertise to answer questions and provide necessary information (Bogner and Menz 2009). Flyvbjerg (2011) highlighted the selection criteria in the sample selection considers the different sizes and locations of the firms to ensure validity and reduce bias. While many types of research in developed countries have been undertaken, this thesis contributes to empirical research in developing countries to understand the phenomenon of CE. Thereby the primary data collection is in developing countries, in which cases refer to individual organisations. The appropriate sample size in qualitative research may depend on the study itself. Eisenhardt (1989) argues that there no ideal number of cases to be selected; however, between four to ten cases is usually regarded as a good number. Below are the case selection considerations:

Object of study: The organisations that are involved in the agri-food supply chain, particularly fruits and vegetables from upstream, midstream, and downstream, comprise of growers, distributors, and retailers. The growers have different scales of production, but all produce fresh produce that is supplied to modern markets. The growers that are selected meet the criteria of supplying to modern retailers. The criteria entail structured markets in Indonesia, that according to Supriatna, Perdana, and Noor (2016), provide certain specifications for products, including quality and continuous supply. A major reason for growers to supply to supermarkets is to increase revenue (Sahara et al. 2015). Some of the samples are smallholder growers which make up the majority of horticulture growers in Indonesia. However, smaller growers face difficulties in entering modern markets due to their inability to meet the grades and requirements imposed by supermarkets, lack of information and credit (Moustier et al. 2010). Therefore, these growers have to involve intermediaries to supply their products to modern retailers. Table 14 explains the sample selection in this research.

Industry: Agri-food industry. This industry is chosen because there is growing concern around the issues of natural resources depletion and environmental impacts of producing food. Furthermore, many authors address that producing food is now considered to be unsustainable, while on the other hand, the agri-food industry is responsible for food security. The growing numbers of publications on CE in the manufacturing industry's technical cycle are considerably more established than in agri-food's biological cycle. The technical and biological cycles have distinct approaches in realising CE. Research on CE in the management studies in the agri-food context is scarce. Thus, this research also contributes to the understanding of CE in the agri-food context. The term 'agri-food' is used in many respects and refers to the agricultural crops that are destined for human consumption. There is inconsistency in segmenting agri-food products (Shukla and Jharkharia 2013). Following Aramyan et al. (2006), this study will use the term 'agri food' for vegetables and fruits, where they are categorised as perishable products. The perishable products supply chain is more complex compared to most product supply chains and more difficult to manage because its main characteristic is its short shelf life and deteriorates quickly over time (Aung and Chang 2014, Karaesmen, Schelter-Wolf, and Deniz 2011).

Location: Indonesia was chosen for the case study because of its status as a developing country. Indonesia is a tropical country that produces fruits and vegetables, however it's position as the fourth most populated country in the world suggests the need for food security. Moreover, urbanisation inflicts two associated problems: the spending on food is higher than that of rural consumers, and the threat to the sustainability of production in agriculture in Indonesia. According to the Central Bureau of Statistics (BPS) (2018), the number of farmers decreased by 3% between 2013 and 2018, particularly in the younger generation. The sample selection is taken from the Java Island because it is the most populated island in Indonesia, with about 46% of the total population of the country, and modern retailers are concentrated in the Java Island. This is in line with Vetter, Larsen, and Bruun (2019) who claim that the modernisation of agri-food in the Global South is delineated through the increasing number of modern markets.

Case descriptions

This section describes the selected case based on their function in the supply chain, divided into three main category, growers, distributors, and modern retailers.

Upstream (growers)

Case A

This company is a corporation operating in West Java since 1998. The company was the first in Indonesia to utilise a greenhouse commercially by growing vegetables using the aeroponics method. The respondent has been working as the site manager for over eight years, responsible for the process of production, maintaining productivity, quality and availability. There are three cultivation systems implemented by the company, which are NFT (nutrient film technique), drip irrigation, and soil ground. The harvest reaches 2-3 tonnes each day. The commodities produced by this company are leafy vegetables (lettuce, romaine, salanova), fruit vegetables such as tomatoes, cherry tomatoes, mini cucumber, and it has expanded into processed products such as tempeh, and tea. The company also has partnerships with other growers, i.e., carrot producers from Sumatra. All products produced are supplied to leading modern markets, hotels, and restaurants.

Case B

The company is an association or group of farmers operating in Central Java, who were formerly fostered by the Taiwan Technical Mission that provides technology transfer and commodity development, but since 2005 farmers have started to release and start all activities independently. By using the open system cultivation method, they plant various types of fruits and vegetables such as broccoli, tomatoes, Lollo Rosa, romaine, chilli and herbs. Farming products are usually marketed to supermarkets and restaurants with a total of almost 1.5 tons per day. The respondent is the head of this farmers' association. The products are supplied through distributor.

Case C

The company is a small company operating in East Java. They use open system cultivation to producing exotic fruits and vegetables to focussing on a niche market. The company produces some vegetables and fruit products, including paprika, carrots, celery, mangoes, apples, lettuce, pumpkin, and some exotic fruits. The grower supplies the products to traditional and modern retailers according to the type of commodity. They supply directly to one of the modern markets using intermediaries.

Case D

The company is a cooperative of growers operating in West Java. The commodities are grown in different land types; the highlands, medium land and lowlands with different method including open system cultivation, greenhouse, even permaculture. Until now this company has produced 126 varieties of vegetables, fruits and mixed vegetables. The company's activity includes supervising fostered farmers, consisting of 270 farmers in nine different groups. The farmer groups are divided into three districts: Bandung Regency, West Bandung Regency, and Cianjur Regency. Farmer groups in each district cultivate different commodities. For the Ciwidey, Rancabali and Pasirjapu areas, the focus is on highland vegetables, for West Bandung it is medium plants such as chillies and tomatoes, then in Cianjur, it is for lowland vegetables such as herbal medicines, i.e., lemongrass, ginger, turmeric, etc. The company supplies to all retail types, including modern retailers, restaurants, and traditional markets.

Case E

The company is a group of growers located in Central Java Province. This company was founded in 1996 with their speciality of growing zalacca on open system cultivation and having an organic certification. The company started to market zalacca in the domestic market by sending it to various islands in Indonesia. As a centre for planting zalacca, growers who are members of farmer groups sell their crops through the grower association. The growers in this firm also work together with marketing companies and packing houses that distribute domestically and further expands their produce to export market.

Case F

The company is a group of growers operating in East Java, founded in 2000. Numerous commodity growers are involved in horticulture development of potatoes, onions, garlic, carrots, chilies, apples, purple sweet potatoes, as well as cutting flowers and ornamental plants. The company fosters 330 farmers in an open system cultivation on an area of 20 ha. This group of farmers aims to improve the standard of living of the village community and has a mission to improve farmer's living, facilitate farmer groups in growing, create group cultivation, increase farmer productivity results, expand market access and support diversification of agricultural products. The company works closely with suppliers, such as suppliers of seeds, fertilisers, pesticides and universities to create good agricultural operating standards for farmers. The company sells their product to modern retail and traditional markets. They also maintain contacts with food companies to provide raw materials that comply with high grade standards such as chilies, tomatoes, and potatoes. Other collaborations were also carried out with other institutions in the CSR program in the field of agricultural development such as Bank Indonesia, to maintain inflation stability and small businesses. The firm has an extensive use of technology in particular farming techniques classed as advanced, such as mulch technology on conventional land, using greenhouses with sprinkles as well as drip irrigation. The Batu city government also provide support in technical guidance and applications on smart phones that contain the latest technology developments and prices.

Case G

This company is a small company established in 2019 in East Java, consisting of a group of young people who have a vision to be the most innovative agribusiness company. They have a second location in Central Java focusing on growing leafy vegetables in hydroponic methods in a green house and using an NFT channel. The company supplies to modern retailers and hospitality industry.

Case H

The company is a group of growers, located in the West Java Province. Founded in 2009 with 125 growers as members. The farming method is open system cultivation and the commodities cultivated are baby Kenya beans, white radish, tomatoes, carrots, cabbage, and potatoes. These growers specialise in cultivated commodities, adapting to the habits and abilities of farmers in farming these commodities. This growers group cooperates with modern supermarkets and export markets, especially to Singapore. The company received a lot of assistance from Bank Indonesia and Padjadjaran University. The university helps a lot in terms of technology to supply chain management. This model was developed using a dynamic systems approach and participatory action, where it functions to design a lean, agile, and equitable vegetable supply chain system model to meet a structured market. The farming method is open farming on land owned by the members. The company also supports good cropping patterns.

Case I

The company is a group of growers founded in 2009 and based in West Java Province. It coordinates six grower groups that collectively manage ten hectares. The vision of the company as an agribusiness organisation is to be able to act as the best model in superior, sustainable farming, and to always grow and develop with a forward-thinking perspective, by referencing to the reality and culture of its members and using environmentally friendly technology that meets the needs of the global market. They cultivate baby Kenya beans, tomatoes, chilies, broccoli, cauliflower, chicory, lettuce, cucumber, romaine, horenzo and cabbage in open system cultivation and greenhouse. The farming concept built is a partnership in cultivating seeds, fertiliser, harvest, and market with member farmers to supply export needs. Other products are marketed to modern retail and online stores in big cities such as Jakarta and Bandung. The firm also has extensive engagement with stakeholders from the government to universities. One of the most unique breakthroughs is the construction of a gondola that can bring production facilities or crops faster. This gondola cuts the road over a hilly and steep land. Another collaboration they conducted is the JICA (Japan International Cooperation Agency) agricultural exchange program.

Case J

The company is a corporation located in the Lampung province. The main products are Cavendish banana originally from Costa Rica, and Golden pineapple. These fruits are planted in an open system using modern culture methods by company experts and professionals. The company utilises cutting-edge technology in all aspects of cultivation, including land clearing, nurseries, maintenance, and harvest methods, in order to minimise error and waste. They are also fully certified from international GAP. The company sells its products directly to modern markets throughout Indonesia's main island such as Java, Sumatera, Bali and Sulawesi.

Midstream (distributors)

Case K

The company operated in West Java since 1994 and is the intermediary between growers of vegetables and fruits to leading the modern market, with coverage areas ranging from Banten, Jakarta, West Java to Central Java. The types of vegetables supplied are very diverse and divided into three categories, namely vegetables (carrots, cabbage, asparagus, chilli, tomatoes, bitter melon), leaf vegetables (leeks, baby kailan, baby pak choi, baby beans, asparagus, mustard greens, cabbage, broccoli, spinach, rosemary, marjoram, coriander, coriander leaf) and fruits (orange, pineapple, butternut squash, pumpkin). Most of the crops are from conventional farming. Every day the company supplies five tons of vegetables to leading modern retailers.

Case L

The company specialises in supplying tropical fruits to modern retailers (e.g., lemon, melon, pumpkin, avocado, papaya, durian, salacca). The company is in Central Java and started to supply its products to modern retailers, particularly those in Central Java itself, in 2008. This company focuses on selling local fruit to supermarkets in the areas of Yogyakarta and Central Java. As the intermediary, the company has partnership with growers to sell their products to the modern market which has better prices than traditional markets.

Case M

The company is a fresh vegetable and fruit supplier located in East Java, founded in 1997. They distribute fresh vegetables products that supply modern retail for the areas of East Java, Bali, Lombok, Kalimantan, and Sulawesi. The company's main products are leaf vegetables, lettuce, sweet corn, tomatoes, chilies, onions, potatoes, broccoli, oranges, papayas, and bananas. The fostered farmers are growers from several areas. A benefit of the company is assistance in the form of technical, capital and marketing of their crops. Thus, the company serves as an incentive for farmers to produce high-quality products that are acceptable in modern retail. The owner is also active in horticultural marketing organizations and provides training for farmers on how to cultivate and manage good harvests.

Case N

The company was established in 2005 in cooperation between the Taiwan technical mission and Boyolali district government, located in Central Java province. This institution aims to assist farmers in cultivation until post-harvest and marketing can penetrate the modern retail market. Member farmers receive intensive capital assistance in the form of products and guidance and packing before sending it to modern retail in Central Java and East Java. In establishing a harmonious relationship between Aspakusa and its consumers, regular meetings and monitoring by retail are carried out so that products follow market trends. Other relations are constructed with the local government and university to support the latest technology in maintaining the freshness of the ozone system.

Case O

The company is located in West Java, founded in 2010. The company is engaged in distributing agriculture products, especially vegetable horticultural crops, such as tomatoes, long beans, broccoli, mustard greens, and cabbage. Additionally, they provide fresh-cut vegetables that are ready for processing into finished products or food. This is an innovation given to the concept of ready-to-eat fresh-cut products. The application of the HACCP (Hazard Analysis Critical Control Point) system is part of the application of the food safety system used to serve to improve the quality of international standard products. Most of these supply farmers are assisted farmers who receive capital and technical assistance in the form of seeds, fertilizers, pesticides and intensive guidance. This collaboration is intended to result in a high-quality harvest in response to customer requirements. The process is carried out using modern machines and the finished product is stored in a cold storage room before being delivered through cold chain.

Downstream (modern retailers)

Case P

This company is one of the largest modern retailers in Indonesia. It started as a French franchise chain and has been operating since 1996. This retail company provides a variety of community needs such as local and imported fruits, various types of vegetables and spices. The company has a hypermarket concept that is combined with department stores. The company has two market segments: women and families. Most of the products sold by the company come from distributors, and if they come from the growers, this has to be supervised by institutions such as farmer groups. The company has a vision to provide world-class service standards to the community. To support this, the company has a concept (One-Stop-Shopping) that offers a place with a variety of product choices, affordable prices and the best service that exceeds the community’s expectations.

Case Q

The company is one of the leading integrated retail and services based in Japan. It began to develop its retail business in Indonesia since 2014. The company carries the concept of a general merchandise store providing a new retail format in Indonesia, combining the concept of department stores and supermarkets that offer a variety of food products like fruits, vegetables, herbs and spices. The segments of this company are middle to high class.

Case R

The company is a multinational Korean retail group, with a range of three concepts in Indonesia, including wholesale, hypermart, supermarkets. The company sells various products such as fresh produce, food ingredients, clothing, toys, electronics, and other goods.

They also mentioned strong commitments towards plans for expansion in Indonesia, refusal of third parties as consideration on good business ethics and selling products that are of high quality whilst keeping a competitive price.

Case S

The company is an Indonesia-based retail company, engaged in the sale of fast-moving consumer goods. It has two types of retail concept, hypermarkets and supermarkets which have more than 100 branches nationwide. The respondent has the role of merchandise buyer for this company, and responsible for local vegetables and imported fruits. In addition to department stores that sell clothing products, the company also has supermarkets that sell fresh food and daily necessities. The company has been operating since 2004. The brand-new concept offered is where the company makes it easier for consumers to find primary and secondary shopping goods in one place. The retail area is designed to have a warm, pleasant and friendly atmosphere. The strength of the company cannot be separated from its qualified human resources, and the completeness of the types of goods that total more than 30,000 different items at more affordable prices for the low, medium and high-class segments.

Case T

The modern markets established since 2002. Currently there are 96 areas with 100 stores and 14,000 employees. The complete product line in the company chain helps customers meet basic daily needs including lifestyle needs. The focus of their supermarket is on the promise to offer “great value”, whilst its family-oriented hypermarket offers a wide variety of products affordable for buyers who have a limited budget to focus on fresh food, groceries, household products and general merchandise. Their “Extra” is run with a hypermarket concept and targets customers with large-scale needs, so that it prioritises product completeness, availability of quantity and economical prices.

4.3 Data collection

The researcher is aware of ethical considerations when conducting research involving humans, and therefore obtains an ethics approval from the University prior to data collection to ensure the researcher understands the risks. The informant was provided with information and informed consent prior to the interview (See Appendix B). The researched instrument, a semi-structured interview, were used to gather the primary data. This method enables the researcher to ask the interviewees research questions and also allows them to gain deeper insight based on the responses from the interviewees. The flexibility of semi-structured interviews is another justification for their use in this study.

As mentioned, before the primary data collection, the researcher obtained the ethical approval from university committee. A pilot test was conducted to test the interview questions, this involved peer reviews and some of actors involved in supply chains (case A, K, and P). To make sure that participants can answer the questions, and address changes. Following some revisions, the researcher collected data using the fixed prototype of semi-structured questions. The researcher adhered to the research protocol throughout the data collection process, beginning with informing the responder of the research's goal. After giving the information about the research project, the next step was to ask the respondent to read and sign the consent form to ensure that participants are voluntarily participating in the research. This process allowed the respondents to know the purpose of the research and understand their rights, as well as be aware on how to make a complaint. Following that, the interview can begin. The data collection consisted of semi-structured interviews using audio recording and transcription. The semi-structured interview guideline is in the English version (see Appendix A).

The interview lasted between 60 and 90 minutes on average. A walkthrough and tour to see the farm, packing process, store, and facilities helped to understand the business process and implementation of CE in the field. Additionally, artefacts include a company website, in particular the large companies, previous studies, and publicly available annual reports for modern retailers.

The researcher was recruited in the study to assist with data triangulation to support in a more detailed description. Data collection involved visiting the farms, packing house, and store. However, not all cases can be observed due to technical issue of the COVID-19 pandemic, where there are measures that needs to be taken into account. 8 farms, 5 distributors, and 5 retailers were observed.

Table 14 Profile of respondents and data descriptions

Case	Position in supply chain	Type of company	Informant (Number of people)	Informant code	Activities observed	Supporting data
A	Upstream (Growers)	Corporation	Site manager (1)	A-1	Harvesting process, sorting process packing	Company website, archives
B		Group of growers	Head of growers (1)	B-1	Harvesting process, sorting process packing	Archives
C		Corporation	Owner (1)	C-1	Harvesting process, sorting process packing	-
D		Group of growers	Head of growers (1)	D-1	-	Archives
E		Group of growers	Head of growers (1)	E-1	Harvesting process, sorting process packing	Archives
F		Group of growers	Head of growers (1)	F-1	Harvesting process, sorting process packing	Archives
G		Corporation	Site manager (1)	G-1	Harvesting process, sorting process packing	-
H		Group of growers	Head of growers (1)	H-1	Harvesting process, sorting process packing	Archives
I		Group of growers	Head of growers (1) Technical assistance (1)	I-1 I-2	Harvesting process, sorting process packing	Archives
J		Corporation	Quality assurance manager (1)	J-1	-	Company website
K	Midstream (Distributors)	Corporation	Director (1), Director (1), head of marketing (1)	K-1 K-2 K-3	Receiving products, sorting process, and packing	Company website, Archives
L		Corporation	Owner (1)	L-1	Receiving products	-
M		Corporation	Owner (1)	M-1	Receiving products, sorting process, and packing	-
N		Corporation	Head of marketing (1)	N-1	Receiving products, sorting process, and packing	Archives
O		Corporation	Head of marketing (1)	O-1	Receiving products, sorting process, and packing	Company website
P	Downstream (Modern retailers)	Corporation	General manger fresh headquarter (1), Store manager (1), Area manager (1)	P-1 P-2 P-3	Displaying products, breakage process	Company website
Q		Corporation	Supervisor fresh produce (1)	Q-1	Process of receiving products, displaying products	Company website
R		Corporation	Fresh produce manager (1)	R-1	Displaying products	Company website
S		Corporation	Merchandiser (1)	S-1	Displaying products	Company website
T		Corporation	Store manager (4)	T-1 T-2 T-3 T-4	Process of receiving products, displaying products	Company website
U	Stakeholder	Indonesian chamber of commerce	Horticulture chairman (1)	U-1	-	-

4.4 Data analysis

Following Merendino et al. (2018) when describing the sample selection, this research also uses codes and number for the respective informants to maintain anonymity, as shown in Table 14. The reason for keeping the cases anonymous is that the majority of the respondents asked their names and that of the company to remain anonymous. This complies with the GDPR to protect the respondents. Another reason is that using a code is more manageable when comparing with other cases, rather than referring to real identities. The codes refer to the individual cases; in this research, it is twenty cases comprising of ten growers, five distributors, five modern retailers, and one stakeholder informant.

The unit of analysis is the operational capabilities of resources of strategic capability in the agri-food supply chains. The data is recorded and transcribes verbatim in Microsoft Word using manual transcription process by the researcher. Secondary information such as the company's websites were also noted. All the data is imported to the NVivo for data analysis using template analysis.

Template analysis defined by King (2012), is the style of thematic analysis using textual data which are flexible to adapt based on the needs of the specific study. Building the template follows an iterative process, and the core of the techniques is a coding template. King (2012) further calls the template analysis a "contextual constructivist", which believe that there are always various interpretations of a phenomenon. In consistent with the philosophical stance critical analysis, adopting the template analysis, therefore, serves appropriate (King and Brooks 2017). Template analysis in this research uses *a priori* code theme, based on the interview questions and the construct from theory (theory-driven). This is done to extend the level of coding or other themes that might be discovered when analysing rich data, so the results of the study will then be rigorous. This research uses NVivo 1.3 through an iterative process, thereby supporting the relationship between the variables. This process represents retroductive abductive in critical realism. Prior to reading the data transcribed, *a priori* codes are created based on the template analysis. The following diagram Figure 13, explains the process of doing the analysis while maintaining the iterative process until a fixed template analysis are made.

The main theme is the four strategy capabilities of NRBV pollution prevention, product stewardship, and sustainable development. King (2012) mentioned that code are labels applied to data, to identify them as an instance of a theme, whereas coding involves the process of identifying said pattern. This thesis uses Ketokivi (Ketokivi 2006) and Fisher and Aguinis (2017) who used the technique in theory elaborating theory. While this thesis does not focus on identifying the outcome of NRBV, it explains the relationship NRBV to CE and builds evidence for the propositions.

The next process is identifying and categorising actions into operational capabilities. Following that is to match the capabilities with the CE principles to draw the line between NRBV and CE, supporting the postulation of this thesis.

The process of matching the capabilities and CE principles is in line with Yin (2018) for explaining, building and pattern matching. The process of data analysis is as followed:

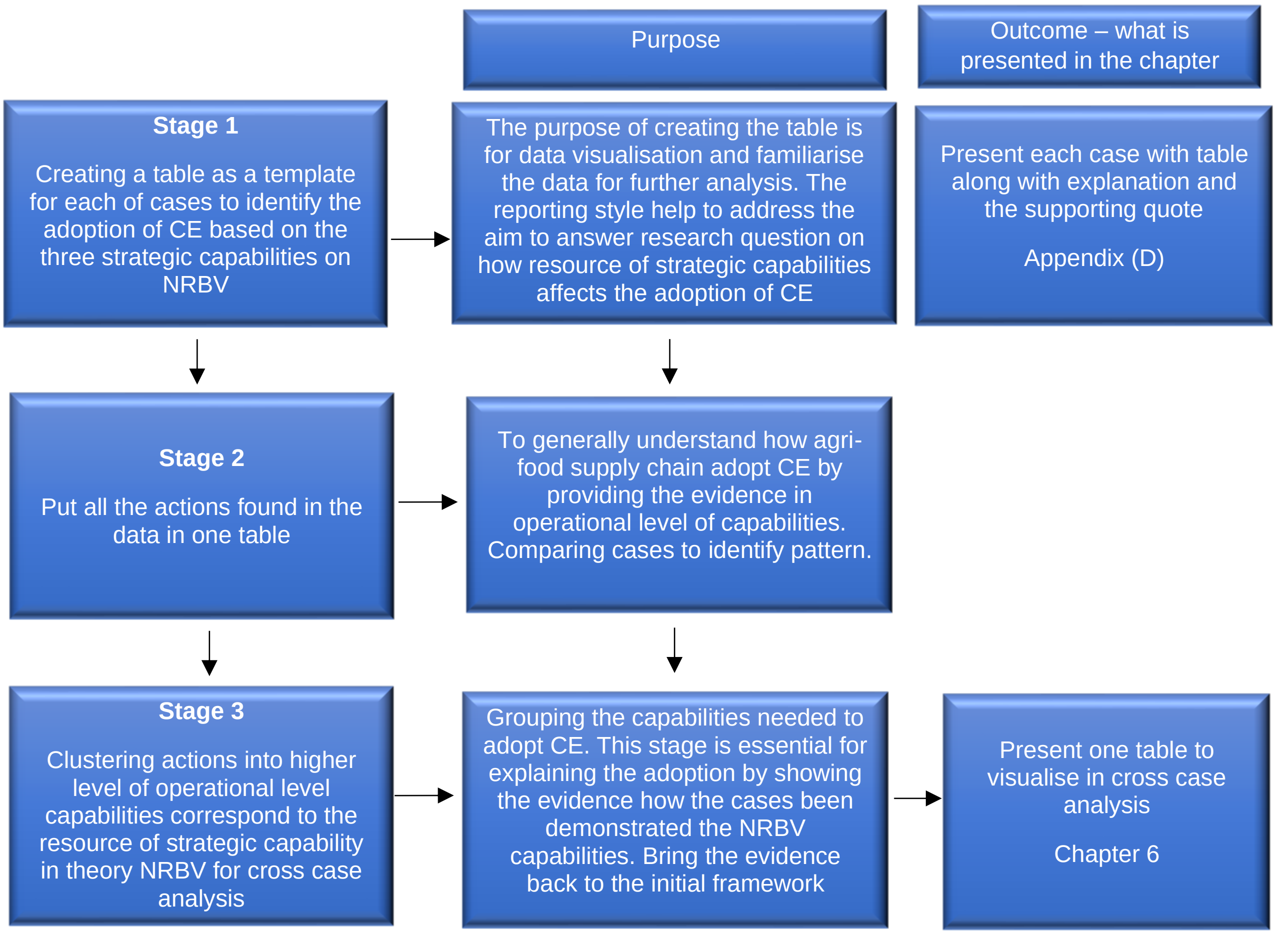

Figure 13 Process creating template

Upon completion of the template analysis, the within-case analysis was conducted, divided into five main themes following the key construct of NRBV, as shown in Table 15. Then, a cross-case analysis was carried out to determine the similarities and differences between the cases. Table 15 provides an example of the coding structure.

Table 15 Example code structure

Primary codes	Secondary codes	Theme	Theme concept
Delivery scheduling	Planning	Internal operation in waste prevention	Continuous improvement
Improving facility	Operational process		
Intensive supervising cultivation	Control		
Learning from stakeholder	Learning process		
Implementing company value	Culture		
Partnership with growers/suppliers	Securing raw material	Collaboration in the supply chain	Stakeholder integration
Regular visit	Coordinating		
Comparative study abroad	Learning		
Audit internal and external	Food safety compliance		
Re-usable crates	Using sustainable material		
Collaboration with a nutrition expert	Product development		
Promotion	Food waste mitigation		
Drip irrigation	Technology adoption	Technology adoption	Shared value
Technology for food processing	Food processing		
Wastewater treatment	Waste processing		
Automatic packer	Future orientation to advanced technology		
Wireless irrigation system	Digital technology		
Community involvement	Social	Social orientation	

Following the categorisation phase, the subsequent process involves case and cross case analysis. Within case analysis is used to comprehend an individual instance, whereas cross case analysis is used to identify similarities and contrasts between cases.

Despite the strength of the qualitative method, there are a number of limitations to adopting this method. Some limitations are influenced by researcher perception; they could be biased, have limited time available, and the response might be affected by the respondent’s condition. As the data collection was conducted during the COVID-19 pandemic, changes to respondents' condition influence their responses, where most responses state that the pandemic is a real example of disruption that affects their businesses. To minimise bias and ensure methodological rigour, this research follows validity and reliability tests (Yin, 2018), shown in Table 16. Despite of the criticism of the interpretive and subjective quality criteria, it is essential to consider the quality criteria in the case study for its validity. These include internal validity, construct validity, and external validity. Internal validity means it is imperative that the results of the study are compared with other established or previous studies and that patterns can be identified. Construct validity refers to the operational measure that usually uses published studies and multiple data sources such as supporting documents and field observations. Whereas external validity is the ability to use replication of multiple case studies (Yin, 2018).

Table 16 Quality criteria and strategy on this thesis

	Strategy in this thesis	Research stages
Construct validity	This research uses a multiple case study and triangulation of data sources: interviews with key informants who are involved in the agri-food industry and stakeholders, field observations, companies' websites. 20 multiple cases, 10 growers, 5 distributor, 5 retailers, 1 stakeholder	Data collection and analysis
Internal validity	This research use template analysis in data analysis. Within case and across case.	Data analysis
External validity	Findings can be generalised through the replication of findings in multiple case studies.	Data analysis
Reliability	This thesis uses case study protocol, to develop key informants' databases in order to maintain a chain of evidence.	Data collection

In order to assess the quality of research, this thesis use some of accepted standards as criteria for good research practice upon which the research will be judged. Therefore, to ensure the achievement of quality standards, this thesis follows the trustworthy criteria proposed by Abushaikha et al. (2021) as outlined in Table 17.

Table 17 The trustworthiness criteria

Trustworthiness criteria	**Method of addressing trustworthiness in this thesis**
Credibility: the degree to which the results appear to be a reasonable representation of the data	• Data triangulation, this thesis uses multiple sources of data consisting of primary data collection, by interviewing respondents and visiting sites. Some of the archival data are used to gain more information such as company background, and some activities that cannot be covered during the interview due to time constraints • The work has been published in peer-reviewed Journal of Business Research, as well as presented in conference. Result: The refined circular capability framework is improved from the feedback
Transferability: how applicable the research study's findings from a certain context are to another context	• The findings are analyses with a clear description • Informants provide diverse experiences and perspectives Result: conceptual model was evaluated against published work on FLW using CE as an intervention
Dependability: the degree to which the time and place of the findings are specific and resolve to a consistent explanation	• By presenting the within case using template to analyse the data have the purpose is to present case sample equally and remain relevant to the current situation

	• Audit trail from internal and external examiners getting feedback from peer reviewed • The data were gathered using semi-structured interviews triangulation, site visits, company websites and archives from previous research Result: consistent interpretation of events
Confirmability: the amount to which conclusions are drawn based on participants and phenomenon rather than on preconceptions from researchers	• Researcher remains objective to avoid bias during data analysis • Procedures for data analysis are defined and documented • Discussions among academics are conducted to further clarify data • Coding is carried out with an iterative process continuously to reduce bias Result: Template analysis were refined
Integrity: the degree toward which participants' misconceptions or evasions impact the judgments made	• Involving multiple informants • The researcher confirms responses back to all informants to ensure that they are accurately documented • Respondents' consent and willingness to participate in the research are taken into consideration Result: No misleading bias from interview
Fit: extent to which research findings correspond to the subject topics investigated	• The purpose of the study is to investigate the application of CE in tackling FLW in a developing country • All findings are then matched to form a pattern that extends the NRBV theory in the agri-food sector Result: concept applies to the supply chain as sample were comprehensively investigated from the agri-food sector from the upstream, midstream and downstream
Understanding: participants' willingness to consider the findings as a plausible depiction of reality	• The research has been disseminated in a conference seminar and published in three-star journal paper • Researcher discussed results to practitioners and scholars for feedback Result: Researcher gains further insight from scholars and practitioners, contributing to robust and understandable findings
Generality: the degree to which the findings provide light onto various angles of the phenomenon	• Multiple sources of data were gathered and analysed • Interviews involved all main actors including the upstream, midstream and downstream of the supply chain Result: Varying aspects and point of view of the events (CE) were observed
Control: the amount to which elements of the theory is impacted by organisations	• Each case sample comprising of the upstream, midstream and downstream could influence the initial propositions, resulting in the need to refine the propositions Result: With regards to the empirical findings, this thesis reveals the capability and resources needed to implement CE, which were discovered as the antecedents of CE principles. Adding a new principle, social responsibility, to

	be integrated along with the other six CE principles. Strategic capabilities of pollution prevention and product stewardship in NRBV theory are interdependent and not necessarily path-dependant

4.5 Summary of the research methodology

This thesis utilises the multiple case study design for theory elaboration in answering the research question. The philosophical critical realism and the nature of this study are abductive, retroductive and perspective of NRBV. Twenty cases along with one informant were selected using the purposive sampling technique to represent the agri-food supply chain, with different size companies to allow a comprehensive overview of the supply chains involved. The data are then collected using the triangulation semi structure interview, field observations, secondary data companies' website as well as company reports. Data collected are analysed using the within case and cross case template.

CHAPTER 5 WITHIN-CASE ANALYSIS

This chapter explains within-case analysis using template analysis (King and Brooks 2017) that has flexibility in any philosophical approaches. The details of information entailing case samples have been explained in chapter 4. Consistent with the philosophical stance of critical realism in which explaining the mechanism on how strategic capabilities affected CE adoption in the agri-food supply chains, the template has been arranged based on a theoretical lens. So-called *a priori* themes and link with the data to understand the uniqueness of the capabilities that exhibited in each case meet with one of the principles of critical realism retroduction process as the key epistemology assumption. Following that, the template is used for cross-case analysis using replication logic (Martin and Eisenhardt 2010) across cases to seek the similarities and differences between cases or retrodiction (McAvoy and Butler 2018). This process is supporting the elaboration of the theory using case research where there is a balance between theory and data.

The structure begins with the explanation of the main themes and “proof quotes” to support “storytelling” to create understanding (Fawcett et al. 2014). The themes arranged based on the main themes that are corresponding to the main strategic capabilities of NRBV. Internal operation corresponds to pollution prevention strategy, collaboration in the supply chain corresponds to product stewardship, technology adoption and social orientation is corresponding to sustainable development. Another theme presented in this chapter is the factors that are considered barriers to CE to achieve research objective no 3. The within-case analysis briefly highlights the results of identifying actions within the operational capabilities and the relationship to CE principles. The term of operational capabilities in this thesis refer to the capabilities in operational level of each resource of strategic capabilities. Meanwhile, due to the number of samples, it is impractical to present the details of operational capability discovered. Therefore, to avoid excessive detail in the within-case analysis, the supporting evidence is presented in the tabular form in the appendix along with answers from respondents (Appendix D and Appendix E).

5.1 Thematic analysis

5.1.1 Upstream supply chain

CASE A

Internal operation in waste prevention

Case A has made various efforts in waste prevention starting from the planting stage; the respondent revealed that they implemented a cut off system. *"Regarding the product that does not meet the specifications, we know that it won't pass through, so we cut it in, so they then won't proceed to the next process" (A-1)*. This process allows early detection to prevent plants from not growing according to the specifications, thus in line with **waste elimination**. The respondent explained that *"How we deal with this is by carrying out the treatment process from the beginning in that we select which are good fruits; so if we find a fruit that's small, for example, we don't leave it like that, we have it cut out immediately which is better than having to wait until it is absorbed and becomes waste" (A-1).* The greenhouse technique is an example of waste prevention illustrated in **Figure 14.**

Figure 14 Greenhouse

By continuously evaluating, case A claimed they successfully reduced the amount of waste on farm as showed in Figure 15. *"We calculated, the calculation is about 5% [...] approximately from 1.3 tons, which is what we calculated previously, the waste is only around 200 kg" (A-1)*. They collect data for evaluation in the future to be able to comprehend which process causes food waste. The respondent admitted that they did not make any records before but recording the waste of products that do not meet specifications has now become the firm's target. This, therefore, showed how food waste had become a major concern for the company *"There are records, and that has indeed become our concern. Previously we did not do it, and now it is a must for us" (A-1)*. These actions reflect the principles of **waste elimination** and **economic optimisation.**

Figure 15 Farm landscape

Collaboration in the supply chain

In maintaining the continuity of the production, case A created a production plan, arranged the supply of material input, and made sure to build a proper relationship to learn with their partners. Having a strong partnership would be particularly beneficial when the firm is facing difficulties obtaining raw materials, without which the company activity is most likely to be hindered. *"Yes, when it happens, we do trade even if the quantity is not suitable" (A-1)*. The respondent explains that seed and fertiliser are the most important for them. *"Mainly seeds and fertiliser, we got them from importers and local distributors" (A-1)*. In securing the raw material, this company describes its procurement process *"We do a forecast for three months, then we create purchase orders, delivery orders then the stock deal. Everything is arranged under the customer's needs such as seeds, packaging, distribution, and then we send it to them when everything is settled" (A-1)*.

Case A collaborates in product development with their customers, such as creating ready-to-eat products, introducing new variants, and deciding what packaging they use as a way of **economic optimisation**. The respondent stated that they plan and have good communication with their customers but does not have any specific certification or standard operating procedure apart from regulating their internal operations. Meanwhile, in the monitoring process, oftentimes retail representatives visit the farm to evaluate and ensure the quality and continuity of products. The principle, **leakage minimisation,** is therefore indicated by case A.

Technology adoption

The use of technology also contributes to natural resource use. The respondent stated that this is done by using aeroponics in greenhouses without any substrate, allowing the roots of vegetables to hang freely in the air and preventing any potential contact with soil and dirt. The use of greenhouses by the company is beneficial to protect the crops from disease and pests, as shown in picture A. *"Compared to conventional techniques, we do so much better because almost the crops we grow are in greenhouses, so this reduces the risks from being exposed to by pests and disease" (A-1)*.

With the extensive use of technology, greenhouse and NFT, the respondent claimed that the company's approach in executing its activities is considered highly efficient. This judgement is also based on the system and the equipment the company use for day-to-day activities*. "It's efficient enough with the measure productivity and uniformity" (A-1),* the respondent stated. In the future, Case A plans to move to more advanced technology to increase their productivity and efficiency. By applying aeroponics systems, nutrients are delivered precisely and directly to the roots, and plants also easily absorb oxygen for photosynthesis. As the respondent state, *"using this technique, enables plants to grow faster not like conventional methods. We also plan to invest an indoor plant factory which integrate with the microclimate" (A-1)*. This case also uses digital technology to communicate with other stakeholders for information sharing, distribution channel, and demand data sharing. As such, utilising digital technology demonstrates the principles of **waste elimination** and **economic optimisation**.

Social orientation

In terms of social aspect, the respondent explained that they give products that are still edible to their own employee and does so based on several reasons; *"Yes, when the demand for vegetable decreased but the product is over produced" (A-1)*. This is done by the company when surplus occurs with decreasing demands. So, instead of turning into waste, the company chose to give them to the employee, where products are still edible and safe for consumption (see Figure 16). This reflects **social responsibility.**

Figure 16 Social media to inform sustainability program (Source: Case A social media)

Barriers in adopting Circular Economy

Furthermore, the respondent explained how much the seasonal factor affects their activity. *"It affects both quantity and quality factors, especially in the rainy season" (A-1)*. The rainy season is especially challenging for the company, as it generates great loss in quantity and productivity. *"What we do is to plant more unsusceptible vegetable varieties into cropping pattern so the output in terms of weight will be better" (A-1)*.

CASE B

Internal operation in waste prevention

Soil management and plant rotation are perceived to be an important aspect to produce high-quality products. Case B maintained soil quality through the use of manure, a conscious effort to avoid overuse of chemical pesticides and keep their agricultural land from non-organic waste, ultimately supporting the principle of **leakage minimisation**. This company exhibits environmental awareness from the Prima 3 certification, which ensures food safety requires them to maintain their farm, *"we have certification in Prima 3 [from the Indonesian government]. It is prohibited that the land has traces of or scattered plastic on the farm; there is no pesticide packaging left. So, the farm must be kept clean" (B-1).*

By producing high-quality products and protecting them with reusable crates, the firm minimise the risk of rejection from customers, hence, displaying **environmental consciousness.** Case B also presented the principles of **waste elimination** and **economic optimisation,** as they discussed the significance of having a production plan in place to ensure that they can meet the demand agreed upon with customers. The crops are classified based on the specifications to then be sold in various distribution channels such as the traditional market and hospitality industry (restaurants), demonstrating **cascades orientation** and **economic optimisation**. Products with good specifications are brought to distributors specialised in modern retailers, whereas products that fall below specifications are sold to traditional markets and the hospitality sector such as restaurants. *"we've sorted the products according to the specs, to the distributor for modern retailers, traditional markets, and restaurants" (B-1).* This case, however, does not process crops into value-added products because it follows the needs of the market.

Collaboration in the supply chain

This company was aware of the importance of streamlining work with the help of technology and demonstrated how collaboration with NGOs from Taiwan brings significant transfers of knowledge by assisting them in applying good agriculture practices. The Taiwan Technical Mission also taught the importance of technology, ways of cultivation and developing new variant of plants *"Yes, some we innovate ourselves, some of which we got from Taiwan. Literally, innovation from bureaucracy is rare. So, I have noticed that those who have innovation are the growers and the company, such as seed companies are more innovative" (B-1).* The respondent added that many innovations came from growers themselves and the company, but innovations from governments are relatively rare.

Case B has also partnered with universities for soil testing. The firm obtains information, from numerous information exchanges amongst groups and companies. Case B also collaborate with the seeds company and provide a demo plot to test its performance, although the relationship is transactional. As they attempted to develop new variants and be commercialised as part of product development, Case B expects the government to support. *"We often ask for help from the government […] we have production but can't consume it right? [...] Say we have to plant head lettuce, maybe some doesn't know lettuce, oh what is this like? how to consume? In the end, because they [consumers] didn't know, they didn't buy it, the one who bought it already knew, oh this for kebab, this is for salad and so on […] people do not know a specific commodity. We have beetroot, but they don't know what for?" (B-1).*

Technology adoption

In its operations, case B fully relies on simple tools because they have a hilly contour that prevents them to use machinery as depicted in Figure 17. Yet, the company suggested that there would be many benefits if they used modern machine and greenhouse as the risk of crop failure would be minimised, *"Unless we use a greenhouse, I think the risk is low, the risk of failure, but we cultivate on a conventional expanse, we depend on the weather" (B-1).* Case B also stated that there is no customised machine available that can work on their farm. *"Actually, you can use a machine too, but considering our ability, the terrain is a bit sloping, the land is small, but looking for the level of efficiency is better using a machine" (B-1).* The company orientation for investing in advanced technology is not featured due to the doubt on the given condition of the farm. This case also uses digital technology like social media to communicate with other stakeholders for information sharing, distribution channel, and demand data sharing, which indicates the CE principles of **waste elimination** and **economic optimisation.**

Figure 17 Hilly contours

Social orientation

In response to the question of social orientation, case B focus on the welfare of the members, *"We have a community of growers here, joined in one group and what we must do is consider their welfare, we do train and sharing between us" (B-1).* There are dynamics within the group, but case B understands this as one of the consequences of human interaction. They also help each other and divert to other channels for below specifications and repurpose waste to be given for animals feed around the farm, implying principles of **waste elimination** and **social responsibility**. *"[For below specifications] we sold them to the local market or the traditional market" (B-1).*

Barriers in adopting Circular Economy

Case B did not record the amount of waste due to the lack of the importance of food waste and waiting for other growers to make breakthroughs. *"I think because no one has yet dared to start doing it" (B-1).* Some of the reasons for waste occurred due to damage in the handling process, high specifications from modern retailers so that products end up being rejected, or the process of delivery where products are often damaged. *"For the modern retailer, the level of damage low, maybe there is not even 10% [...] But, if the products are for the traditional market, growers just put the crops into one basket, it can be 30-40% damaged" (B-1).*

CASE C

Internal operation in waste prevention

Case C believe that waste prevention can be achieved through producing high-quality products. An array of actions was exemplified on waste prevention: improving the internal operations, work ethic and productivity, soil management, understanding the characteristics of soil, using superior seeds, and following market needs. This reflects **waste elimination** and **economic optimisation.** Long experience in the hospitality industry affects the leader to emphasise work ethos and innovation as a culture of the company. *"I think my previous background that was quite long in the hospitality industry affects my mindset. Service excellence is always at the top of my mind […] Listening to the customers' needs is important. Therefore, I have a value that I am not just producing products and selling them to the market, but really providing what consumers need" (C-1).* Having a close relationship with employees, creating a culture of belonging to build synergy with nature and raising awareness are ways to produce quality products, *"I am transparent too because I consider them [grower] as my own family [...] they aware if there is" (C-1).*

Collaboration in the supply chain

Case C believe that the network is an essential resource; they collaborated with many parties such as seed suppliers and pest control manufacturer. Apart from ensuring material input, collaboration serves as a means of information sharing and evaluation. *"I am not an agricultural person, I have friend, okay, I'll try […] yes, collaboration, use these seeds, use that seed, which one is the best" (C-1).* While knowledge transfer occurs mostly with close partners of the company, by information sharing, the company is more willing to experiment with them on applying new seeds to plant. Collaboration with a nutritionist in product development was also made to produce the uniform-sized fruits, *"I tried to do an experiment to produce the same size fruits, at least 10 to 20 grams missed" (C-1).*

The company builds strong relationships by maintaining a two-way communication with modern retailers in order to constantly improve, have stable cash flow and display **economic optimisation**. This involves regularly sharing information on harvest time, and harvest scheduling is used instead of regular planting to ensure both parties are prepared. Delivery scheduling is also implemented to maintain the value of products. Retailers are welcome to visit the farm for monitoring and control the quality and handling process. As such, the principle of **maximisation retained value** are reflected**.**

Technology adoption

The company is supported by many aspects, including technology. When it comes to water treatment, the company utilise an irrigation system to minimise water use and anticipate water shortages for some vulnerable plants such as paprika. In the future, the respondent expressed a desire to use a hydroponic system, *"I thought of it as hydroponics" (C-1).* The respondent currently farms in a conventional open setting but is preparing for drip irrigation to practise precision farming. As a result, every plant receives a precise amount of water it needs every day, which are highly convenient for dry seasons.

In response to the orientation of applying technology on the farm, the respondent believed that they are still convenient enough to not depend on technological advancements as much in terms of efficiency, and in fact prefer community empowerment from locals. However, this differs greatly when talking about digital technology. Case C suggested an example on how useful digital technology are in aiding the process of learning and marketing. This suggests that digital technology reflects **waste elimination** and **economic optimisation**. Case C continues to update the progress of growth by sending picture to retailers; to ensure the retailers are ready to accept the products. *"I send pictures of the plants regularly to buyers, to make sure they are ready to receive my products when harvest time is due, and it helps their procurement system and planning […] communication is wonderful in a team" (C-1).* Information that would contribute to the improvement of the system are also obtained by the company through the internet, such as making organic pest control and cultivation techniques.

Social orientation

The company's perspective on **social responsibility** entails empowering residents near the farm to support the economics of local people, *"someone come to me, they said no work, then I accept him as a worker" (C-1).* Additionally, the company receives and collects waste from dairy farmers nearby to process them into manure. This builds a mutual benefit relationship; while the dairy farmers clean their animal husbandry, growers will have easier access to manure, thereby illustrating **cascades orientation** and **economic optimisation**. Such collaboration with the local NGO is also establish for reforestation, *"so, there is a farmer group, they created an NGO for reforestation to conserve water which now is more difficult to get." (C-1).*

Barriers in adopting Circular Economy

Some barriers in adopting CE were explained related to consumers perception of the size of products and imported products. Case C stated, *"I am now starting to develop products to a more personal size, i.e., for one-time consumption" (C-1)*. *"Consumers usually do not eat large amounts of fruit in a short amount of time, so the fruits tend to become wasted due to this habit; in response to that, I will attempt to grow fruits to a more desirable size and then pack them in personal sizes. This is expected to meet the needs of consumers who want fresh fruit but in an appropriate amount" (C-1).*

Lots of imported fruit and vegetable products have entered Indonesia and many buyers want to import commodities, so the company expects the role of the government to include promoting local products and build awareness so people will still prefer to buy them in the

Indonesian market, and not let imported products displace them. *"The desire of consumers, 'I want imported products, then they buy imported ones, but we are local, and the government also support the local products and promote them properly (build awareness of using local products)" (C-1).* This conveys how the respondent realised how the role of government will help local growers.

CASE D

Internal operation in waste prevention

Case D exclaimed that the key factor to having high-quality produce is the seed. However, most superior seeds are imported, as the yields from local seeds are oftentimes unable to meet modern retail standards. *"To be honest, the seeds that are owned by Indonesia, even though they are certified, in terms of quality are not very good, below imported seeds" (D-1).* Understanding nature is important to the firm as they need to pay attention to weather conditions that could cause crops failure: *"We try to understand nature, how it works […] we must understand how nature works. There are indeed some obstacles, but we must know" (D-1).* Case D applied a production plan and divided the crops into several locations, as they have separate farming locations, in aims to minimise the possibility of crop failure and therefore avoid obstructing supply. *"For the modern markets, they are not only looking at how we can send high-quality products but also these have to be following the quantity they want, and continuity must be maintained" (D-1)*. This reflects **waste elimination** and **economic optimisation.**

Collaboration in the supply chain

Strong engagement with the grower members in case D appeared to be an important aspect. All supporting material is organised by the group as they are a part of a cooperation. They apply a mentoring model, called ToT (training of trainers), to members to educate them about essential aspects of the agriculture business, such as how to cultivate, market orientation and cropping systems. *"Such as seeds, fertilisers, we also provide them, we provide them so that the growers will only concentrate on cultivation, maintaining quality also how to maintain the continuity of the products" (D-1).* To ensure a smooth information flow, regular meetings within the organisation are held. *"So, the meetings no longer needed invitations or notification as everything is running automatically. Every Monday they would come, we gather, and we would talk about cultivation, about cropping patterns and so on" (D-1).*

Technology adoption

The system of cultivation in case D is a combination of modern and conventional. Some areas still use a conventional technique, especially *"Those 270 assisted growers conventional" (D-1),* but this does not mean that all growers in the company have not applied any type of technology at all. From the three locations of the company, the main farm used greenhouse and irrigation fertigation, but these technologies had not been applied equally to the two other locations another system. Case D also uses drip irrigation as shown in Figure 18. However, there is a system where the farm is connected to an Android system for precision farming. *"There is a greenhouse that is already irrigated, including what has already been done, by applying a connection to the Android" (D-1).* The company has implemented these advanced technologies to help streamline activities and use resource efficiently. **Waste elimination** and **economic optimisation** is reflected also from the use of digital technology like social media to engage with other stakeholders to share information, establish distribution channels and exchange demand data.

Figure 18 Drip irrigation

Social orientation

As the current background is a boarding school, the firm have assisted farmers comprising of 270 assisted farmers in 9 farmer groups, in which 9 farmer groups are spread across 3 districts; therefore, the cultivation of vegetables differs. By providing the supporting materials, the company aims to ensure that the farmers can focus on producing, or else the farmer may not do so. The company does not want farmers to feel conflicted; they only need to focus on cultivating plants, maintaining both commodity quality and continuity of shipping.

The company has a mentoring process to disciple students who will be given in-depth knowledge about agribusiness and entrepreneur skill and are expected to become successful growers in the future. This concept makes case D beneficial educational institutions in terms of economics. *"It means that the economy, educational institutions-based economy, with this great potential, actually can be utilised" (D-1).* The respondent added that the economic sector in Indonesia, especially in agriculture, will be advanced if the sector is willing to collaborate in a larger scope with the Islamic educational institutions in West Java. This action displays an awareness of the principle of **social responsibility**. In addition, the company hopes to build greater cooperation with many stakeholders in the future.

Barriers in adopting Circular Economy

Case D explained how they are confronted with problems to reduce the damage due to the vehicle that facilitated a cooler. The products are at risk of damaged or have shrinkage due to the temperature changes between the farm and customer stores. *"Well, this is on the distribution side, in which until now we have not been able to lower the damage" (D-1).* The respondent further explained that waste occurs because of behavioural factors, for example during the post-harvest processes. *"Post-harvest processes: first is harvesting the vegetable products, then they are put in sacks, after entering the sacks they arrive at warehouses, the warehouse sorting processes then continue for shipping, shipping to the market is in plastic or in a sack too, then later on putting on display is not feasible" (D-1).* This suggests the need for a selection of reusable packaging and maintaining a good handling process.

One predicament that seems unfortunate for case D is the unequal development in the company. *"This technology could have to be owned by other groups of the assisted farmers in the company, for example, the fostered farmers have a system as we have here but it will be difficult for them because they will certainly have obstacles in terms of capital support; apparently that we have gone this far is not because of our ability but because of receiving CSR, the support of another party" (D-1)*. So, the respondent explained that it would be very difficult for others in the fostered farmers group to implement the same system, mainly due to by capital constraints.

CASE E

Internal operation in waste prevention

Case E is a group of growers who cultivated salacca in the open system, making them exposed to the risk of pest and weather changes that cause fruits to decay before harvest. *"There are some [products] are decayed before harvest [...] flies are the biggest problem" (E-1).* Having applied organic system, made use of superior seeds, and tied with the regulations, no chemical substances are used to tackle the pest and force growers to keep clean their farm from non-organic waste such as plastic. Case E confidently claims to produce no pollution, *"there is no pollution here [...] we are fully organic. Usually, they dropped by themselves on the field and having decomposition, the growers just leave like that" (E-1).* The respondent further added that besides rotten fruit that can be waste, the tree midrib is a source of waste if it is not managed properly. As such, chopping the midrib using a machine and to use it for fertiliser supports **leakage minimisation** and **environmental consciousness**.

Respondent claimed that the short life of products forces them to align with the schedule between harvest and delivery time to optimise economic value and **maximisation of retained value**. Besides understanding the characteristic of products that need to be stored in decent air circulation, maintaining the performance of the growers in post-harvest handling is vital to minimise waste. Case E sets delivery schedule for the shipment and reduce lead time to reduce waste occurrence. The selection of packaging that can be reused also affects the disappearance and level of products damaged during delivery that need to be addressed, thereby indicating **environmental consciousness.**

Collaboration in the supply chain

Since case E opened a new distribution channel to export their products, they have developed a standard operating procedure (SOP) to collaborate with the local government. The company adopts good agricultural practices (GAP) that regulate cultivation activities to be undertaken properly, especially in terms of technology, product safety and environmental sustainability that are regularly supervised by the local government and reviewed every three years. Case E is registered as an organic producer and packing house. The registration allows traceability if there is a problem, *"every time there is a shipment in one box, the registration number is attached, the registration number showed where the products from, it can be traced" (E-1).* A strong relationship with the local government is perceived as an advantage for case E in their process of learning as well as actively joining international exhibitions to open a new market. These actions can be observed as an effort of **leakage minimisation.**

Technology adoption

Case E still depend on the usage of simple equipment such as hoe and sickle; there is almost no modernisation. This is because the use of the machine is not economically viable and incompatible with the size of land, *"The land here is indeed very narrow, so the technology does not grow due to the price of technology, with an area of land may not be in accordance with the capacity if applied technology" (E-1).* However, case D have started looking at the adoption of technology. They created a chopper to process frond that can be used for fertiliser. *"I already think about the use of technology, for instance, chopper machine, I feel grateful that* *it was well-received by the members when the frond is chopped it will be quickly turned into fertiliser" (E-1).* They also used a conveyor for the sorting process and blowers in the packing house.

Seeing how important technology is, as it will improve effectiveness and efficiency, the respondent was enthusiastic in explaining the details advanced technology that they want to invest in the future. *"The technology for fertiliser is strongly related to the cultivation, such as piping for the distribution of liquid fertilisers, post-harvest drying oven, censor for sorting process those technologies, especially [machines] to processed food like chips and canned fruits" (E-1).* The use of advanced technology is also supported by the local government who discoursed to use pressure gas for prolonging the products, which currently remains under research. Case E found the development of digital technology useful, as the website and social media help them to observe any updates of market trend and acquired knowledge so that they can make improvements, hence applying both principles of **waste elimination** and **economic optimisation.**

Social orientation

The nature of the company is a group of growers, so they focus on community empowerment. They involve members in processing animal dung for fertiliser and collect dues to support their needs. The firm also regularly meet to help each other solve the problems that they are facing, endeavour to open new markets to improve economic welfare*," we need to expand the market. fruits processing such as canned fruit, then it will improve the economy of the growers" (E-1).* Case E also donate the products for the community, orphanage, and boarding school. Meanwhile, products that are not fit for human consumption are given to the community that have livestock, which displays the principle **social responsibility.**

Barriers in adoption Circular Economy

An internal factor that is still considered as an obstacle is the difficulty in keeping the performance of human resources in post-harvest handling. Employees with no experience in the field raise issues because errors will occur more often, affecting the quality of the products, *"For the employees, if we use the new workforce, who have no experience, we will find it difficult, many errors, but if you have a skilful people, it will be good" (E-1)*.

The economic aspect is the reason for the current selection of packaging that is still not effective in protecting fruits from damage and the usage of plastic is somehow unavoidable. Case E admitted that the use of packaging depends on the customers' demand. For domestic markets, bamboo is seen as a common packaging. Although it may be considered sustainable, it poses a high risk of damaging the products. *"We use a bamboo basket […] the cost of packaging is expensive if we change to more protective packaging, so it will burdensome packaging costs" (E-1)*. It goes the same with technology that required high investment.

CASE F

Internal operation in waste prevention

Case F alluded that waste occurrence during planting is most likely caused by weather, pest and disease. The company's efforts to respond to this are by conducting intensive plant care, soil management, plant rotation, and revitalising the plant, *"Yes, there must be plant rotation" (F-1).* Respondents illustrated that there had been an anomaly in the climate that caused commodity to be damaged, resulting in a considerable loss. *"Yes, automatically. We've planted red peppers before. 150 hectares, 50 hectares here, but there is a climate anomaly, and it is constantly raining. In the end, the fruits fall out, and we suffered a huge loss" (F-1).*

Case F demonstrated the **cascades orientation** and **economic optimisation**, as the company has a wide range of market segments; the segment is determined by the quality of the product and how growers want to distribute their products. They send their products from modern to traditional market, and processing factories. The respondent also expands the market segment to export market*: "The potatoes that we exported to Singapore yesterday from, here from Junggo, the outsiders. People the importer, said, your potatoes are the best in the world" (F-1)*. The below specification products will be processed further, such as to crisps, juice and vinegar. **Waste elimination** and **economic optimisation** is seen with how Case F supplies its products according to demand forecasting, so they are able to make a plan for the process of planting their product.

Collaboration in the supply chain

As a group of growers, they have an extensive network contributing towards progress and development. They optimise group functions, build a network throughout Indonesia, and collaborate with local government, a state-owned bank, and non-organisations from abroad. The firm obtains raw materials such as fertiliser from other firms, but they empower members to produce their needs, such as seeds, *"We make seeds by our members. We can do seedling. We learn from various collaboration and information exchange programs with many parties, even from abroad. Many programs from overseas like Netherland has reached us. From Taiwan, Korea, China, Japan" (F-1).* In addition, the company has gained much knowledge through the standard operating procedure given by Japanese people, and they taught them about growing, cultivation and water management. *"Well, we learn from Japanese people in* *cultivation technique, after harvest, how the post-harvest process is, how the grading is, what the requested spec is, then how do we send it, how about the cold chain management SOP" (F-1).*

Case F established a standard operational to organise a business activity to be more systematic and on purpose. The certification is also really needed to convince customers that the products are appropriately managed, *"Yesterday we do have certification for organic product, but this certification only for certain commodities. There are some growers who has applied to Prima 3. But usually, if the activity has been heralded" (F-1).* These certifications include organic certification, certification of Prima 3, and quality assurance safe for consumption. The respondent stated that they also had applied GAP (Good Agricultural Practices). *"Yes, some of us have applied good agricultural practices" (F-1).* The application of GAP has affected the way growers do business properly: focus on producing quality output to be more environmentally friendly and comply with food safety. As such, **leakage minimisation** is applied.

The respondent explained that for packaging, the company does not use any recyclable packaging materials, *"Yes, we do not use plastic, because we focus on B to B. Business to Business. We usually use Styrofoam that can be reused" (F-1)*. The respondents have a viewpoint about their network that are helpful in updating information and follow trends. *"We are also in the contact group for Indonesia horticultural business. From these activities, finally, there is an identification of this horticulture centre" (F-1).* This reflects the principle of **environmental consciousness**.

Technology adoption

Technology adoption is not limited to only farming equipment as it also applies to the media case F uses to obtain information, as the respondent states: *"There is a group of potato expert or Siapik, it is an application. I get knowledge from Youtube, on the internet, we then share it with growers, so that the mindset will change to be bigger and higher" (F-1).* Through this application, the growers have access to new information and sharing with experts and other grower groups. Local government is also considered very helpful by the respondent, *"For the farming, there are Smart City apps here, it gives us information and updates about vegetable price" (F-1).* The use of digital technology such as social media and applications showcases principles of **waste elimination** and **economic optimisation**.

Social orientation

Case F focuses on the welfare of the members. Information as a key of development as the respondent stated, *"There is growers group gathering, we sharing about cultivation, we discuss the current trend, solve problems, and source funding" (F-1).* The company had formed a collaboration with Indonesia central bank, *"Besides ministry of agriculture we also have the central bank, Bank Indonesia. In 2018 we held a horticultural cluster in the national region, and we are in second place. Because we build up and develop business partnership and development in this company" (F-1).* This reflects **social responsibility.**

Barrier in adopting Circular Economy

The firm believe that some waste cannot be used as fertiliser if they are caused by pests. *"Now, because it's time for the harvest to be evenly distributed, we must be afraid that it contains bacteria or something, we have to dig deep into the soil there, we immediately put the rotten fruit in the ground" (F-1).* In response to applying CE, the respondent found overseeing human resources challenging. *"Managing human resources is tough. They have been told not to litter, but they keep doing it. Lack of commitment and awareness of human resources and a group dynamic is somewhat difficult to tune into a more sustainable direction. For example, with these retailers increasingly running online, automatically, if we carry out a partnership activity, these growers might not commit, so there are worries because the risk is not only hundreds of millions, that are billions. If only from 1 commodity" (F-1).*

CASE G

Internal operation in waste prevention

Case G prevented waste by having an accurate forecasting system. They claimed that understanding the target market and knowing amount of demand will prevent waste. *“Here we use a system, cycle, what we plant is according to the demand. What we produce is based only on demand” (G-1).* Thus, represent **waste minimisation** and **economic optimisation**. The respondent mentioned how to maintain continuity related to the planting cycle and soil management applied*. “Firstly, it is planting management, and there should be a market guarantee. The key is that as long as we found the market, then later to form a pattern that will be actualised automatically, we will regularly harvest. We can guarantee it will not pass 45 days. Every 45 days, we will harvest immediately […] When we talk about the market, it is related to the demand. Per season or quarter, we use that as a reference to crease planting cycle, and it will determine what will plant, a quality standard that is on-demand, it is the continuity” (G-1).*

Collaboration in the supply chain

Case G explained that they are open to any form of collaboration both with customers and suppliers; it is essential to build an open and decent relationship. *“We are quite open if other parties want to come for a visit […] If there is the consumer that doubts us, we always have our door open for them if they want to visit the farm” (G-1).* Case G maintained communication with customers and build loyalty. *“If it is about us to the customers, we usually give them advice first about the storage because they usually do it for once usage and not all kitchens have a big storage, so we use styrofoam as reusable packaging to help maintain the temperature. Secondly, we also give them suggested usage because not all restaurant has good knowledge about what is good and bad” (G-1).* This excerpt suggests that the case displays **environmental consciousness.** Furthermore, the respondent added that to keep the consumer satisfied, they try to maintain product quality as consistent as possible until it reaches the consumer. *“In terms of appearance, hygiene until it reaches the consumer, we pay attention to that. We maintain the freshness 100% because we only harvest if there is a demand only” (G-1).*

Technology adoption

The respondent explained clearly that technology application in farming is actually not as fancy and complicated as it is portrayed it to be, *“If we talk about technology, many people see it from videos that hydroponic seems sophisticated and fancy, but it is not. The facilities we use are table installation, but a working tool is probably more like the TDS meter. We use Tri Meter, and It is divided to check temperature and pH” (G-1).* The respondent explained that they have been applying a system named NFT (Nutrient Film Technique). *“We just using water pumps, from one reservoir of water nutrient we lift it with a pump then we flow it with NFT system that it coincidentally has a slope” (G-1).* They also have started to use the greenhouse on their farm, *“The function of the green house is not to eliminate the pest because it is impossible; it is more to minimise. So, to do the pest control, it is easier if we use the greenhouse” (G-1).* The use of greenhouse based on what respondent stated is mainly for pest control. On the other hand, the respondent revealed that the habitat of lettuce as their main priority is in high land, and due to the agro-climatic conditions of the location, they chose to use hydroponics. *“The function of hydroponic apparently to manipulate the weather so we can plant it in the lowland. As for lettuce itself, actually, they are not growing in lowland. Their natural habitat is highland” (G-1).*

Social orientation

The company are confident in their product quality and target market, in response of a question discussing low product quality. *“We will definitely pass it” (G-1).* They never send their product to the traditional market. *“No sell it to the traditional market), it is already windfall for the other growers” (G-1),* the respondent convinced that probably the traditional market is not their target, and they do not create a low-end consumer segment. The company refrain from any forms of donation as they highly value reputation. *“We set up a business, how come we like to donate, then there will be a question from them whether this product is bad or not selling well” (G-1).* However, they prefer other forms of **social responsibility**, such as donating money to orphanages.

Barriers in the adoption of Circular Economy

The company responded with a striking view to the implementation of integrated farming that aims for sustainability: *“It is already applied” (G-1).* The respondent expressed very openly that looking into issues faced in agriculture are crucial, where agricultural problems in Indonesia today relate more to the problem of income. *"There are two big problems in Indonesia agriculture, growers funding and market guarantee" (G-1),* Indonesia are still far from being concerned with the environment due to problems. The largest issue currently is still about funding.

Case G had to burn unmarketable products because it will disrupt price if they divert them to traditional markets. *“Later, the growers who do conventional can be suffered because of the price will be drop. The capital operational because the technology was assembled and so on, the components are on average still from the outside, right? Tell me if, for example, compared to the market selling price, it has arrived. Who doesn't want to have a fantastic look in Indonesia to apply this technology?” (G-1).*

CASE H

Internal Operation in waste prevention

Case H prevents waste by establishing a production plan. The extensive experience in the agricultural industry taught case H the value of market segmentation, hence, they allocate products based on the market segments following the specifications. The perfect specifications are sent to export and modern retailers, while the below is sent to the traditional market as the manifestation of **cascades orientation** and **economic optimisation***. "We sell to different markets, we call it market portfolio […] Grade A to modern markets, below is to traditional markets and since we expand our market to export even the specifications more* *stringent" (H-1).* This means the case does not process the product into value added product because it follows the market's need.

Production plans and applying integrated pest management have implications to cropping pattern, and the company must know the demand to fulfil customers' orders. The respondent gave an example of the production plan and the buffer for anticipation of failure or off-grade products. *"So, if I count each commodity, it is different. For example, in mustard green, the product specifications are 1 to 1.42 per case. Oh, it means 1 kilo if 20 tons means 20 thousand population. Well, 20 thousand population is on grade. The off-grade must increase by 30% as the anticipation" (H-1).* The application of timing, treatment and learning harvest chart in every commodity is crucial in **waste elimination** and **economic optimisation**. *"Oh, it means we have to harvest properly and understand because out planting cycle is like this, has to be on time, on target then where we send it, when is the time, how much, what the product specifications are, what level of maturity. We learn from harvest chart each of commodity. So, treatment for plants and harvest patterns must be maintained" (H-1).*

Case H explained that agriculture is complex, and many things need to be managed, but the respondent believes whoever controls the production with a system will control the market. *"We have our seed patterns, plant patterns, storage patterns, delivery patterns, maybe the difficulty is obtaining superior seeds because it is not standard. I still believe that whoever controls the production base, will control the market. This means that the production base with the system has quantity and quantity" (H-1)*, Case H claimed that they implemented GAP (Good Agriculture Practices) as guidelines for growers for better agricultural practices while protecting the environment, demonstrating **maximisation retained value.**

Collaboration in supply chain

Collaboration is essential for this group of growers to make sure everything is done properly. They arrange cropping patterns and plan what commodity should be planted to their members. The system built by case H currently has a structured system, with 13 coordinators and their respective roles, providing effective communication. Respondent explained that many collaborations had been settled with case H from modern retailers, government, central bank, and university. With modern retailers, quantity, specifications, and market trend are communicated. Case H further explained that each modern retail has different standards, and case H ensures that proper discussion and information flow goes well. Understand the standard operating procedure of modern retailers to be able to implement well. *"Modern retailers have rigorous standard operating procedures (SOP). Oh, every modern retailer has different standards, and we need to understand. There must be a planting date, the are strict"*

(H-1). Case H continues to train the growers about certifications to assure the product safety and quality, Prima 2 and 3. This indicates **leakage minimisation.**

Technology adoption

Digital technology adoption is important for the company to stay updated on real-time communication with various parties to discuss any problems about farming and provide information about the use of products that may or may not be used. *"Yes, now there is a group, WhatsApp, everything is just done" (H-1),* sharing information through social media platforms proved to increase their work efficiency. Applying digital technology can thereby be observed as **waste elimination** and **economic optimisation**. Information is an essential key in developing various innovations applied that will support the company's future growth. Respondents revealed that growers are now open with technology. They can use gadgets. The use of these gadgets supports the fast transfer of information. *"There is already technology now. What is happening to nutrition? They use it, but it is for the benefit of others, social media, and others" (H-1).* Respondent stated that growers are now open with the development of technology, other than for entertainment purpose, the use of technology is for information sharing with many parties.

Social orientation

Case H have strong relationships among members, and the formation of this group of growers was an initiative of the community. The member welfare is vital for this group; with the access to export markets, the increased selling value will impact growers' welfare. Compared to the domestic market, that has long been influenced by uncertain market conditions. They also encourage young people to involve as growers and hope that they can bring new thinking as it is a lucrative field. This reflects **social responsibility**.

Barriers in adopting Circular Economy

Case H encountered various difficulties which caused crop failure due to weather and disease. Some crops are unharvested due to lower selling prices because of the over-supply market, while harvesting costs higher. *"Plant often damage caused by pest, or not optimal, sometimes price drop because of over-supply, then we just leave in the farm, because harvest cost higher than selling price (see Figure 19)" (H-1).* Pests and insects that often attack the plant have caused the company problems, especially in their attempt to maintain good quality in large production volumes. In the solution of killing pests and insects, respondents explained that the company is still dependent on the use of various chemicals and that sometimes growers are careless, *"And there are pesticides that can control all of these phases, like when there is* *rainfall, sometimes they [growers] do not care" (H-1).* There are also group dynamics that make it challenging to align interests and commitment to work together.

Figure 19 Waste of tomatoes on the farm

CASE I

Internal operation in waste prevention

Case I explained that they tried to prevent waste by using superior seeds and meeting product specification based on buyer demand*. "Actually, the modern retail is not too strict compared as export market, we try closely produce to the specifications they want" (I-1).* The respondent explained that they have multiple distribution channels and are focused on fulfilling the demand that have higher value such as modern retailers and export market as manifestation of **cascades orientation** and **economic optimisation**. They admitted that traditional market has uncertain price. *"We supply to almost distribution channels. We preferred modern market and export that have certain price. Although traditional markets take all grades, we are tired of the uncertainty of price, unclear market" (I-1).* The case also does not process as they follow the need of the market.

To produce high quality produce, case I only use the best seed they can have in the market, utilise cold storage to maintain the product value, as well as good planting management. Case I elaborated action of **waste elimination**, *"Seeds are available in market, we just buy it. Important aspect is plant management, such as applying precession use of pesticides, growers use the recommended regulations to not exceed the safe limits. Applications of pesticide for pests, for the disease, yes, we are following IPM [integrated pest management]. We also refer to GAP [good agricultural practice]" (I-2).*

Collaboration in supply chain

Case I prefer to collaborate with modern retailers because of a clear agreement under a certain contract, which covers type of products, quantity, price, and delivery schedule, then product specifications can then be set. *"Because modern retailer has management. It is easier for us adjust the delivery, following their needs, unlike with traditional market. There is no management control there. Price is unstable" (I-1)*. This action illustrates **maximisation of retained value.** Case I often holds meetings to coordinate production plan and to decide which commodity to plant. They must prepare a production plan: an intercropping system between one commodity and another. *"Oh, if that is usually there is a gathering, a member association. So usually we get together at night, if there is new information, new research, we will share, we gather" (I-1).*

Case I has obtained Indonesian national standard certification so that products have met the qualifications and regulation of the government, Case I explained, *"we have national standard certification of SNI and Prima 3*" *(I-1)*. They are preparing towards Prima 1, which cover more comprehensive food safety, environmental, and social aspects which applies **leakage minimisation**. Case I explained, *"the efforts that have been made towards achieving Prima 1 we applied an integrated agricultural system is part of a sustainable agricultural system, right? Yes, for example, from harvest. The harvest results include packing waste, put it into the cows, that way. Later, the cow dung, right? Well, the manure is processed into liquid fertiliser. There are some worm breeders because worms are new, just starting now, yet still not optimal" (I-2).*

Technology adoption

The respondent admitted that the company still relies on the simple tools including hand tractor, sprinkle, and electric sprayer, as technology usage has been not appropriately implemented, and may need customisation due to the hilly contour land. Different views about digital technology are beneficial for case I to coordinate and share information with members, yet some remain not optimal. *"The communication with pesticides company, some are via telephone, use video calls, take a picture, and we show the progress. We also share information by WhatsApp group, share any information. And to update and learn the latest information through social media" (I-1).* Applying these activities displays both **waste elimination** and **economic optimisation**.

Case I have used advanced technology, such as automatic irrigation system, however, the system experienced an error in testing. On the other side, the respondent expressed the importance of technological application in helping simplify job, collaborating with local government or universities. *"Yes. Still very conventional in terms of tools, but what's good here that we already have a gondola for carry our harvest. A greenhouse and drip irrigation but not all area. If the internet yesterday, based on the research of IPB, called My Agri, that's an* *application for agricultural education, there is still a lack of internet usage here, not user friendly." (I-2).*

Social orientation

Case I expressed their interest to develop a collaboration between agriculture and tourism, as explained by Case I, *"Agro-tourism, I hope so. Combining education and tourism sector is seen as a trend and a great opportunity to introduce agriculture to the community." (I-1).* One form of **social responsibility** is supporting GGHH (Global Green and Healthy Hospital), Case I explained, *"one of the missions of GGHH is how the hospital empowers local growers to teach the patient so that the patient can do household farming, the harvest can use for hospital consumption, so is not far away. The impact will reduce footprint ecology, its footprint if in the environment." (I-2).*

Barriers in adopting Circular Economy

The inability of growers to observe market demand is in line with the lack of knowledge they have in the planting system, which leads to a significant disadvantage for them*. "Like before, we really depend on the market, while the price on the market is inconsistent, so for example, hopefully, next July the price of tomato will be high; hopefully, next month broccoli will be expensive. So, no term said growers want to plant something and price already settled." (I-1).* The unavailable facility of processing waste, low awareness, commitment issue, result in waste ending up in landfills and burners as illustrated in Figure 20, *"Not easy to follow the Indo-GAP because in the form of a Law, yes, that even me too lazy to read it. Unlike Global GAP that is simpler. That's already been regulated. The problem is to educate the growers, and it is not easy, you have to be smart. Like here, the members still use plastic and sacks to carry crops. Because the container likes to get lost. That's the hard one. Yes, even though in the past it was, now, it's already good at that time. They only care about something related to except for real harvest yields. And that's toward money, that's just what matters is financial, not yet recording waste because they perceived pointless. Yet, no one has said that waste is money like you." (I-1).*

Figure 20 Waste of tomatoes

CASE J

Internal operation in waste prevention

In its internal operation, Case J referred to the Good Agricultural Practice (GAP), *"There is GAP, but it's still in process" (J-1).* This system is focused on the better farming system that covers more practices, and it is related to the local government regulation as one of the standard operations regarding distribution permit for fruit and vegetable. *"We referring to GAP or Permentan there are some chemicals that are not allowed to use in a certain degree" (J-1).* Specifically, about the chemical pesticide, Case J showed great concern about this, *"For now, it has already calibrated because we got authorisation from PSAT, there was a test for chemical content. If the chemical content is high, then it will not pass" (J-1).* The regulation that was supposed to be only from the government level was not adopted by Case J as the company regulation, which applies the principle of **leakage minimisation.**

Furthermore, with the increase of awareness regarding pollution and waste, Case J has been trying to apply Go Green practice as the company stated, *"Yes, it's from the realisation, some companies also already asked it, for example, if vegetables is packaged using plastic they ask whether the packaging could be recycled or not" (J-1).* In addition, Case J explained that some companies rejected some packaging that are unrecyclable. In Indonesia, there are already specific requirements about this issue. Case J divided waste into product and non-product; due to the short life cycle of fruits and vegetables, the company often process the product waste by giving them out, *"We usually send them to the restaurant, actually the condition is still decent, but it's more about the appearance meanwhile the quality is still good" (J-1).*

Collaboration in the supply chain

Case J acquires their local and imported seeds from some breeders outside the company. The sole reason why the company does not acquire it from one specific internal group is because of the inability of an average of fruits and vegetable suppliers*. "Almost fruits and vegetable suppliers; they are unwilling to or don't have capabilities to produce seeds by themselves. Also, the regulation is difficult" (J-1).* Case J is well aware of the importance to ensure the continuity of the supply as they focus on securing the seed source, especially on the seasonal fruits and vegetables like tomato and melon.

As of now, consumers are more cautious of the origins of the products. *"They [the customers] want to know where the planting location, whom parties' plant, was it well planted" (J-1).* Following the trend, case J communicate with the customers regarding the product and sharing knowledge. *"Once happened, red spinach fades off, because lack of knowledge, they asking why. It's because naturally like that, but we keep serving it, from which farm, then who will purchase to answer their complaint" (J-1).* In addition, associations outside the company also often collaborate to develop new seeds and regular visits for on-farm research.

Technology adoption

Case J faces some problems in some natural factors like rainfall, sun lighting, flooding. To reduce the negative impact of weather, the company has been using the greenhouse as their cultivation technique. In the future, the company has a plan to develop a machine for wrapping as they stated that *"We do have a plan for vegetables, we want to buy automatic wrapping, it's still on our plan. but we do have something like belt conveyor already" (J-1).* The company realises the importance of technology in supporting sustainability. However, for now, they have yet aim for a breakthrough specifically for renewable energy, as their focus are still on the application of technology for work efficiency in the company. *"Its way more for the speed because it's also impossible for us to add new people because our rooms are also limited, so we usually switch it with technology" (J-1).* This case also uses digital technology like social media (see Figure 21) to communicate with other stakeholder for information sharing, distribution channel, and learning. Therefore, applying this technology reflects **waste elimination** and **economic optimisation**.

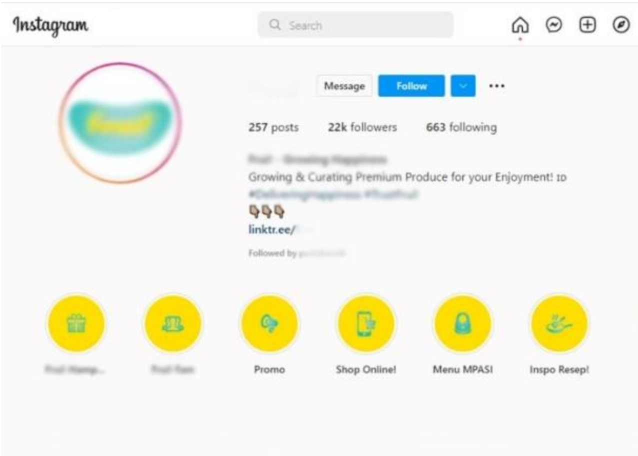

Figure 21 Social media for supporting sales (Source: Case J social media)

Social orientation

Case J has not explicitly shown any form of social approaches. The firm stated that they do not give away products, even when they might still be edible for people in need except for animal food and compost. *"No, [we do not donate]" (J-1).* Instead, the company has specifically allocated products to donate that does not come from the waste they generated. *"We specified it; in other words, we allocate budgets. But if it is already inedible, then we do not give it away, but if there is a specific programme for employees, then we usually took it from the surplus of production" (J-1)*. The source of donation is from the quantity of overproduction then leave it to the management regulation as the company stated: *"For example, we have over-production, 110%, then the 10% depends on the management regulation, and for instance, the 5% to be given out to people" (J-1).* Specifically, Case J explained that they do not have any partnership with other parties in needs when it comes to the donation, *"Not yet because the quantity is small, it still not fulfilled" (J-1).* This action indicates the principle of **social responsibility.**

Barriers in adopting Circular Economy

Case J faced various obstacle in adopting CE. The company realised that there is a lack of knowledge about the concept. *"Sorry, I don't think that I know the concept, but if you mean integrated farming, I know one company did that" (J-1).* They explained that if the company wants to adopt this concept, they have to achieve a certain market scope for economies of scale. The respondent explained how the competitor had implemented CE. *"The first thing needed is the market. The company must see if there are any opportunities or not, as this is what I know from other company is like this. For example, pineapple, after some time then it produces waste. Then it can be an opportunity to become animal feed. Then compost could* *be generated from it [animals]" (J-1).* The company still need a large scale if they want to adopt it, they stated.

5.1.2 Midstream supply chain

CASE K

Internal operation in waste prevention

Case K has been a supplier for 20 years to modern retailers and has accumulated experience doing business. There are four basic principles in achieving the goals: obtaining quality vegetable products, quantity, continuity to consumers, and commitment in payments to growers. Applying waste minimisation, case K explained that understanding the situation and extensive network of growers are the keys. *"We need to understand when high season and low season is. Finally, we know that every customer has character. Weekends, fasting, Eid, weekends in one week or the season in the new academic year when reduce spending" (K-2)*. Agriculture products yield is uncertain. Therefore, they ensure the provision of vegetables by partnering with growers. Unstable supply from growers is one of the factors that need to be anticipated. *"There is no certainty, for sure, with rain, disease, drought and pests. It is common that we are looking for as many locations as we can. Our search is as wide as possible. We look for alternative locations, as it is unbusinesslike if to have one commodity one supplier" (K-1).*

Case K only accept products from growers based on their specifications book of customers to prevent rejection and waste. Therefore, all the products sent by growers have a strict sorting process. The database is used to plan to forecast demand. *"The harvest schedule, yes, I have a database for all growers, both those that are planting for us or free growers. There is data from which I make a forecasting demand and when they will harvest each of the commodities. Then I estimate the buffer stock just in case something bad happens, based on the assumptions from previous events" (K-2).* This reflects **waste elimination** and **economic optimisation.** The percentage from a total of all grower's production, only about 20% can be accepted and meets the specifications for modern retailers. Products that cannot be sold to retail or modern markets will be sold to the traditional markets; this way, case K applies **cascades orientation** and **economic optimisation**.

The warehouse was built with sufficient air circulation, so products will stay fresh while they are being packed with reusable packaging even without a cooling system as shown in Figure 22. This shows **environmental consciousness** of the firm**.** Their warehouse location is in high land which has low temperatures helps the vegetables not to deteriorate. They also have cool storage as temporary storage for vegetables with a longer life, such as potatoes and yams. Case K does not have specific waste management, and gives leftovers to employees to be cooked, or if they are not suitable for consumption, used as animal feed by employees, and lastly end up in landfill if they cannot be utilised as illustrated Figure 23.

Figure 22 Tomatoes packed in reusable crates

Figure 23 Waste from sorting process

Collaboration in the supply chain

Case K also maintains communication within its network, which involves growers, seed producers, fertiliser producers, pesticide producers, as well as an extended network of scholars and the Indonesia agriculture department, to discuss how to realise the development of agriculture actively and opens the opportunity for external stakeholder to evaluate the firm, thereby reflecting **leakage minimisation.** The firms also support capital for growers that cooperate with them. Working with cooperative growers is one effort made to secure a supply, in this case, the products they supply to modern retailers. In terms of procurement vegetables, they explained, *"We are doing four things: first, direct purchases from loyal growers who have priority. Second, cooperation with distributors to traditional markets. Third, purchases from farmers who do not have a market or maybe for the first time want to sell to a modern market and fourth, is through collaboration with partners [growers]" (K-2).*

Technology Adoption

In terms of technology use, Case K sets a delivery scheduling system and uses small conveyors to help in the sorting process and does not rely too much on technology as they argue that it is sometimes not economical to apply and slow compared to humans. After the packing process, the products are placed in a large container or box and deliver using a refrigerated truck. The cooling system is used during the delivery to maintain freshness. Case K explained using little energy in the warehouse, *"We just need lighting, and a small conveyor for the sorting process, the plastic wrap device. Maybe the cold storage requires much energy, but we don't think we use other resources than electricity." (K-2).* This reflects **maximisation retained value** from the firm. They realised that the pandemic is changing the way consumers behave. Additionally, case K mentioned future aspirations to optimise digital technology through online sales like website for promoting products, increase sales and distribution channel (see Figure 24), which will align with the principles of **waste elimination** and **economic optimisation**.

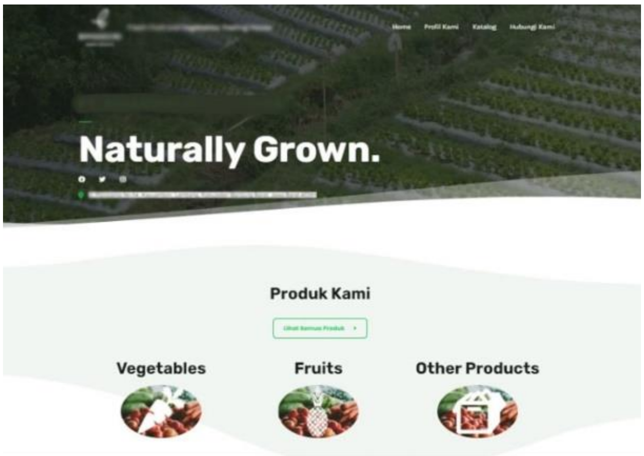

Figure 24 Website for promoting products (Source: Case K company website)

Social orientation

Case K open learning opportunities for school and university to study in their place. They help growers for their prosperity goals because, as an intermediary with modern retailers, their products are purchased at high prices from the traditional market even with tight selection processes. They also involve the local community to be employed as they are labour intensive. Case K has cooperated with charities, such as the orphanage. There are also student activities that have created a body with the name of 'food boom'; this body holds all the goods that have been sorted, which are then cooked and distributed in the Bandung area. But this collaboration discontinued.

Barriers in adopting Circular Economy

Case K explained that every activity that causes waste could be calculated; however, the company does not focus on counting and recording how much waste they have actually created. *"Waste can be counted, but we focus on the specifications rather than recording waste; we have a lot of items of product here that need our attention. Each commodity has a different amount of waste. So, like broccoli from the farm. We do not count waste start from the farm, we receive all kinds of stuff here, I think about 15% waste. For example, leafy vegetable cai sim probably around 10%. (see Figure 25)" (K-2).*

Figure 25 Waste from sorting process

CASE L

Internal operation in waste prevention

Little information about waste is provided by case L because they have a procedure that every product sent by growers has to be clean and based on product specifications. The respondent further said that much waste occurs in the grower's part. Besides, they provide adequate facilities, e.g., warehouse with well-circulated air. They made sure that the lean process in their warehouse and minimise the lead time between products arrived from growers and when they deliver to customers. Furthermore, case L is convinced that delivery schedule is essential to preserve the freshness. *"There is no waste here because the growers have sent it to us with the specifications and clean condition in the reusable crates without any waste. Here it will only take a short time before we send it to the modern market distribution centre so that the products we send are fresh (see Figure 26)" (L-1).* Their actions therefore indicate **environmental consciousness** and **maximisation retained value.**

An accurate forecast is important to estimate how much demand is needed, thereby case L can plan backwards and communicate with the grower and exhibit both **waste elimination** and **economic optimisation.** The company also advises its grower partners avoiding using imported seeds. Back in 2017 when news circulated stating that imported melons contain listeria monocytogenes bacteria which could cause death. Good specification produce will be sent with reusable packaging to modern retailers, and to minimise waste they do test of the fruits, *"We do brix test. If okay, it's okay to execute, send, if don't we rather back off, that means it's not old enough, so we don't want to take risks like this. We have a brix tool test same as the retailers has" (L-1).* **Cascades orientation** and **economic optimisation** appears when case L diverts the below specifications to traditional markets and animal feed, although it is not their focus but rather the commitment to the partners to take all their produce.

Figure 26 Reusable crates

Collaboration in the supply chain

As the intermediary, case L explained the importance of the network and a good flow of information between them with the grower partners and the customers. Initially, case L did not prioritise the partnership with growers because they had no issues with their procurement, but over time case L needed to establish cooperation with growers to ensure a continuous supply. Considering that supplying products to modern retailers is stern, case L realised the uncertainty potentially disrupt their supply to the modern market. Good communication with modern retailers helps case L in forecasting and planning cropping patterns so that products flow well and prevent surplus production, especially case L partners with growers in extensive areas outside the province of Central Java. They learn historical sales, and the respondent is shown what the form looks like when they receive it electronically on a weekly basis. *"I show you this […] every week I receive PO [purchase order] like this from retail, then I make a planting plan, I talk to my growers, and I look at the historical sales so I can make an estimation" (L-1).*

Technology adoption

Case L does not use advanced technology as they have a short time from the arrival of the products from the growers until products are sent to the distribution centre on a daily basis. However, they have a warehouse for temporary storage equipped with a cold storage system. Responding to the question about investing in advanced technology, the respondent explained that advanced technology associate with the use of greenhouse for the grower partners. However, case L must be realistic with a high investment that would bring implications to the price of good sold. Further, the respondent said the products could not compete in the market. Consumers perceived organic fruits to be the same as other imported ones. *"So much capital is needed to build a greenhouse for fruits; yes, it can be done in Indonesia. I had tried it once in 2017 when we used a greenhouse of 2,000 square meters; we had a good harvest, we could sell good fruits, but some were unsold. The products cannot compete in the market because it looks just the same" (L-1).*

Social orientation

Focusing on meeting the needs of modern retailers, products that do not meet specifications are not acceptable, another solution is they sold to the traditional markets. Because Case L has partnerships with the growers, they also help the growers sell the products and the off grades to be sold in traditional markets. This activity also shows that the firm is trying to meet the need of farmers and indicates **social responsibility.** All harvested products from the partner growers are taken. Case L also serves local modern retailer requests, which has a positive impact on the welfare of local farmers. Case L collaborates with growers to produce high-value products whose profits are greater than those received by growers who sell their products to traditional markets. They buy at modern retailer market prices that are higher than traditional market prices. A more profitable purchase by is still being made, even with the planting contract system, where the initial price that has been agreed can change if the market price is higher. *"Let's say, we give the price for planting melons for this month. 65 days later, we will give Grade A prices, for example Grade A is 8,000; if the price will be 9,000, then we will increase by 500, but if the price is 7,000, we will still pay 8,000" (L-1).* Through case L, the growers can gain a stable price because case L has a specific contract price with the modern retailers higher than the traditional markets.

Barrier in adopting Circular Economy

Case L acknowledged that there is little waste at the location and comes from products that retailers reject, but this has been minimised by only sending products following retailer specifications. They can educate their partners on the benefits of processing waste into fertiliser, but not all waste can be processed for fertiliser due to the possibility of viruses or diseases transmitted to the soil. The only way is to burn, as it is the only knowledge, they have that is dangerous to the environment, which remains a problem that must be resolved. The company is unable to replace conventional processes with better technology because they feel that the selling price of their products is still low, and people's purchasing power over local fruits is still very price-sensitive. The company worries that using new technologies such as greenhouses, drones, automatic sorting machines will affect higher selling prices and cannot compete in the market. *"I can afford it if the resources are capable, but the cost is high, and the selling price is the same, right?" (L-1).* Further, the informant clarified that *"the physical appearance is just the same as imported products, but because such a technology makes the cost higher, we cannot compete with imported products" (L-1).*

CASE M

Internal operation in waste prevention

Case M realised its function in the middle between modern retailers and growers. So, it is essential to align quality, quantity, continuity and creativity. In preventing waste case M ensures they supply according to the product specifications the retailers want, this refers the specifications book; thereby they implement the principle of **waste elimination**. *"I talk to growers I want a certain size, a certain weight. If it does not fit, then I reject because retail will reject" (M-1).* To prevent waste, they create vegetables into derivative such as cutting fruit and ready to cook pack as manifested of principle **cascades orientation** and **economic optimisation**. *"My duty is creating product variation such as to make soups, ready to cook, that also included as creativity, products that are not sold; we bundle into soup, for example, carrot that is not in good quality we turn into vegetable soup, that is creativity" (M-1).*

Case M also prevent waste occurrence, that they created a cooler room to maintain the temperature of their product *"We make cooler room even though not sophisticated, because only for a day. As long as it can last for a day because it will arrive in the next day" (M-1).* This cool storage they made still able to maintain the temperature and protect the product to shrinkage or withered. Shipping process is considered a vital aspect, so delivery schedule is important the way the product is being shipped with reusable packaging will determine the product quality when it arrives to consumer destination, thereby demonstrating **environmental consciousness** and **maximisation retained value.**

Collaboration in the supply chain

Case M treat information as an essential resource for their growth and development. *"Retailers even often sharing their problems, since the very beginning they face an obstacle, then we helping to find the way" (M-1).* With the growers, information exchange helps them to solve some problems together. *"From that, we finally often to meet each other, we support like this. So they support us also. I support to the growers. We communicate. For example, there was something new, and then I ask them how much it is, whether it can be continued or not. Can be adequately adjusted if there is a sudden change. If there will be a complaint like, why is it like this. Why was yesterday only a little? For next time I will cut it. If there is nothing, then I will take them back. At the end, they will be such as natural selection. If for people that have been with us, they will say [,.,] later tell us, if the product is lacking, I will fix it" (M-1).*

Case M open and cooperative to growers, which grower who is able to cooperate with them. *"I will offer later like let's team up. I will give the seeds, SOP [standard operating procedure]" (M-1).* Meanwhile as part of the support to growers partners case M has developed to produce fertiliser collaboration with LIPI, *"Yes honestly for fertiliser production I coordinate with LIPI. LIPI has research, they revealed that microbe is produced from fruits" (M-1).* Through the collaboration, the company is able to absorb more knowledge to produce fertiliser and evaluate their cultivation performance. As such, the firm applies **leakage minimisation.**

Technology adoption

The respondent explained that the support of technology such us hydroponic is essential for their development, however, apart from financial constraint, there is still a great deal of activity that can be done manually, circumventing the need for technology. Further, the respondent explained how their partner growers rely on simple tools. *"The role of technology is important. For example, I often invited to be interviewees at first. But growers still traditional and not easily adopt the technology. At the end I'm willing to be educated, want it or not I have to be open and educated; and helping how to make my growers to be efficient and effective on the farms although technology is not only machine but cultivation technology" (M-1).*

Another view about the digital technology adoption perceived beneficial for case M are coordinating, sharing information and promotion, which reflects **waste elimination** and **economic optimisation**. It is explained by the respondent that they have started to use several social media to promote their products *"I use social media for communicating with my partners. I do branding here, starting from Facebook, from IG, WhatsApp I branding myself, I* *put it in whatever it is. In those groups, I didn't bother, I took a picture. Wow, I have guests from this. Then I upload. So that is branding" (M-1).*

Social orientation

Case M explained that they take several measures to reduce food waste; initially, they donate their waste products as part of **social responsibility**. *"Yes, I have been considering it recently. Initially, I donate it." (M-1).* According to the respondent, it is preferable to donate them rather than sell them in the traditional market. *"If I sell it to the traditional market, it will only frustrate me because it will be returned at a very low price, for example, potatoes. Rather than that, I weigh them and search some mosques and give it for free" (M-1).* Apart from helping the company in reducing waste, it can also serve as a form of charity. Case M also practices **social responsibility** by assisting growers in producing high-quality products and empowering growers' to be financially independent by allocating money in daily that took from money spent on a cigarette, so growers not dependent on the bank.

Barrier in adopting Circular Economy

Case M not processing waste, so if there is waste in their warehouse, they throw it away in the garbage bin. Furthermore, the respondent pointed out that the food waste they generated is considered minor, and they barely do any calculation to measure it as the respondent stated that *"We do not record it. Just let it go. Frustrating. Better we focus on other things that required more attention" (M-1).* The respondent with his recent statement that this food waste issue is something that makes them have to do more additional work if they want to handle it in a proper way that is why they do not record any calculation and just let it pass by.

CASE N

Internal operation in waste prevention

Case N in implementing waste prevention is guided by an accurate demand forecast, ensuring that they order the appropriate quantity of products from their grower partners. *"We order according to the purchase order from the customers based on product specifications. Usually routine, stable, so the growers who have sent regularly know, the stock is minimum, unless there is additional order, we contact them [growers]" (N-1).* They accept only products that comply with the standard specifications desired by consumers, thereby minimising consumer rejection, and apply the principle of **waste elimination** and **economic optimisation**. *"For waste in here is the leftover of vegetables that being scraped, or there are rejected vegetables that cannot be used anymore (as shown in Figure 27)" (N-1).* Waste also often accumulated to landfill as illustrated in Figure 28. They also admit that another way to reduce waste is to schedule deliveries, use proper packaging and use refrigerated trucks to keep vegetables from wilting. This reflects **maximisation retained value and environmental consciousness.**

While their primary market is modern retailers, partnerships with growers enable case N to divert products to other distribution channels in the event of surplus production that reflected the principle of **cascades orientation** and **economic optimisation**. *"We help them to sell it to the traditional market when surplus" (N-1).* Another way to repurpose waste is to give it to employees or to feed it to animals. *"The one that still can be recovered or utilised, we give them away to the livestock" (N-1).* Case N does not have any waste processing; as the respondent stated, waste is deposited in a trash hole and burned. The company stated that they plan to have better waste processing, specifically in creating compost, *"We do have a plan to make compost ourselves from waste that cannot be utilised, but until now it has not been implemented" (N-1).*

Figure 27 Waste on farm

Figure 28 Waste to landfill

Collaboration in the supply chain

In updating information and knowledge, case N maintains a good relationship with the local government. They also receive guidance from the government, *"Mostly we get information* *from the government, and there are some training and exhibitions, many of parties in horticulture are involved so we figure out new things" (N-1).* The government's role in providing information and giving more spaces for the company to develop their capabilities is also accompanied by the support from the Department of Agriculture or Food Security, *"We are informed, there should be this; for example, certifications, we are informed about that" (N-1).* Case N requires all partners to have certification of Prima 3 for food safety compliance. *"Yes, we have required our partner to have certification of Prima 3 […] there is a threshold in using pesticides for food safety" (N-1).* Regarding the use of sustainable materials, case N admitted they lack knowledge about what material they use for packaging, whether it was recyclable. *"We do not understand about this material can be recycled or not. We just follow the customers. If they want us to change, that is ok as long the price matched" (N-1).* This shows that case N demonstrates **leakage minimisation.**

Technology adoption

Case N is aware of the value of technology in assisting their work in becoming more efficient. Case N has an ozone filter for wash the vegetables before packing and some simple tools for wrapping. *"We have an ozone filter for wash the vegetables and only use wrap machine for packing (see Figure 29)" (N-1).* Specifically, in managing their waste, the company put their concern on how they could recover their waste into something valuable *"We really need to utilise and recover them [waste], for example, those that are thrown away might actually be processed to be composted" (N-1).* Their future aspiration of technology is a technology that can preserve the products and automation of packing system, *"it is necessary to preserve the product, and automatic machine perhaps naturally. We have not thought about that because the cost is expensive, we need to prepare more budget. So, for now, we utilise what we have, still labour intensive" (N-1).* Both **waste elimination** and **economic optimisation** is reflected as this case also use digital technology such us social media for for sharing information and demand data sharing, and internet for learning.

Figure 29 Ozone filter

Social orientation

The company stated that they sort waste into what can be reused and what cannot be reused; for the latter, Case N typically donates them to the community in need. *"The waste that we discard has already degraded and cannot be reused" (N-1),* the company stated. The remainder that can utilise is given to the livestock. *"There are those who take them; employees, livestock growers. Employees and growers with livestock typically take the waste, which also helps them feed their livestock" (N-1).* This effort ensures that the waste is appropriately processed and does not end up being thrown away, as it may still be valuable to some parties. The distributor's role as a link between growers and modern retailers can improve growers' welfare, as modern retailers purchase at a higher price than traditional markets. Case N also welcome for students for internship and conduct research in their company, therefore exhibiting the principle of **social responsibility.**

Barriers in adopting Circular Economy

The lack of knowledge still become one of the barriers that Case N faces. The respondent stated that they have no knowledge about the concept and how to adopt the concept, *"I do not really understand about that concept [CE], but for now we throw products that already decay and cannot be recovered anymore. The one that still can be used, we give it away to the livestock" (N-1).* Their knowledge is only limited to give away the waste for the livestock. Furthermore, the company stated that the CE concept is still complicated for them to comprehend and clearly show a lack of understanding of the concept. Case N attempts to develop waste processing machines have been thwarted thus far due to the high cost of investment and technical expertise required to process waste. *"Still not yet [...] it is costly, required the knowledge to process. Moreover, the raw materials need to be provided, so yes, not yet" (N-1).* The company explained that they keep daily records of the stock they have, and the quantity of products sold but have not yet considered waste. They also experience the barrier of hilly contours, so using machines such as tractors can be inconvenient, as illustrated in Figure 30.

CASE O

Internal operation in waste prevention

Figure 30 Hilly contour

Case O explained that they had accumulated experience contributing to improving their internal process with trial and error to find the suitable process. *“Back to the capacity of human resources of the company, we learn and there are many obstacles, but yes, we learn from year to year, have to experiment, have experience for planting, we know it, not just last year [...] It has been decades, so what process should be, what learning is this [...] this should already be done, that's enough” (O-1).* This action implies **waste elimination** and **economic optimisation** in the firm. Case O illustrated how they assisted their grower partners to produce high-quality products. *“We have assisted our partner [growers] with the extension, recording, documentation and starting from seedling and plant maintenance so that if they really follow it, the harvest will be good and minimise crop failure, which potentially disrupts the supply of products” (O-1).*

Collaboration in the supply chain

Case O explained that having a big company as their customer is advantageous for them because it helps them give direction to comply with food safety, which will also force and guide them in implementing good planting methods and then communicating with their partners to follow global good agricultural practices. *"We are a firm that supplies vegetables which in fact have to be HACCP certified, Halal and Global GAP, so we have to get a trusted source" (O-1).* The company only wants trusted growers with proper farm and appropriate methods. *"So, it's like big customers, especially apart from they already popular customers, they have this brand, they really take care of sourcing, we have to follow, they are Global GAP. They must give the standard quite strenuous for our growers" (O-1).* Since the demand from the consumer with a big brand requires the company to put more significant concern on the farm, coordinate point of location, population of the crops, regulate the chemical usage, which adopts the principle of **leakage minimisation.**

In terms of sustainable raw materials, Case O expressed they are concerned to change their packaging material. However, only styrofoam as reusable crates can maintain a good temperature, and there is no alternative packaging to use at this moment. *"Styrofoam. If we want to maintain the temperature cold after we put it inside the bag, it should be placed in a styrofoam box that we put ice cubes. The styrofoam can still be reused several times. The same is true for plastics, because there is a technical issue of recyclable plastics that cannot be vacuum, they still used conventional ones" (O-1). "We want to use environmentally products; we have done the trial several times, but it didn't work. So, the problem is like this. For example, all our products that are cut, we usually vacuum, so if we vacuum, the plastic don't want to stay, now we fail to use environmentally plastic because of that main problem*" *(O-1).* As such, the firm shows an **environmental consciousness.**

Technology adoption

Case O explained as long as the investment is reasonable for them, they will follow it. Following the customers' request, they were asked by the customers to install HEPA; however, they still consider that looking substantial investment. *"If the investment is not reasonable, we are hard to follow, like in today's example, we have standards. Where there must HEPA in our production room, which is to filter out the particles, it is usually installed in the hospital and the aeroplane, which costs billions, so we said that as long as the customers are willing to pay for us so we can compensate to the product price, right?" (O-1).* Case O illustrated technology adoption they use it to communicate internally, and now they expand their market online. In the past, there was an online market, but it was not exciting because of the low response of consumers, but now it is inevitably consumers start to switch to online shopping, where applying digital technology shows both principles of **waste elimination** and **economic optimisation.** *"We are now working on an online market that is not only business to business but also end customer, already two years ago we have an online market, but we are not focus at that time due to inadequate responses from customers. But now customers are changing to the online market (as stated in Figure 31)" (O-1).*

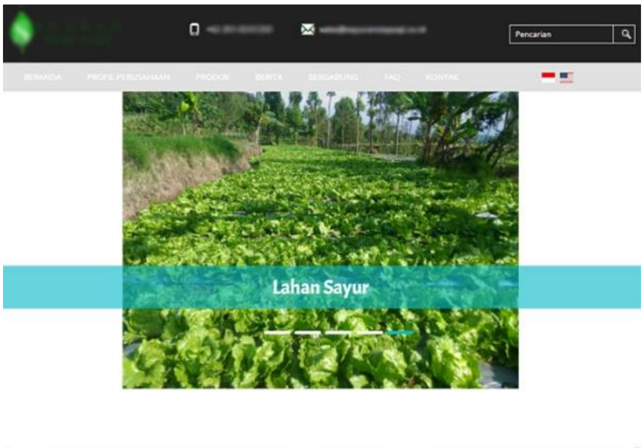

Figure 31 Website to optimise online market (Source: Case O company website)

Social orientation

As a form of social orientation, the company stated that they do not have a specific division regarding CSR: *"In our company, there's no division specified like that, but we have vision and mission to help farmers develop" (O-1).* Besides focusing on the development of growers and their quality of life, they also provide adequate support for their employees. Case O revealed that they do not have any specific division to manage waste. The waste from the company usually getting collected by the resident nearby for their own needs, *"Yes, there are some (employees) also, if they want to take it, we allow it" (O-1).* The company also allows its employees to take the waste. Most of them use the waste to be livestock feed and not processing it to another product. Applying these actions, reflect **cascades orientation** and **economic optimisation**. Case O also added that when they have leftover vegetables, they will give it away to the employees, *"If we have excess vegetables we will give them to the employees, like before, if it's for consumption because they will not re-sell it, they will just consume it" (O-1).* Other **social responsibility** activities are donating to the orphanage, prioritising the local community for employment, and providing health insurance. *"Not all machines can be solved, and everything still needs selection from humans. We are still labour-intensive and involving the local community" (O-1).*

Barriers in adopting Circular Economy

One of the wastes that Case O admittedly hard to manage is packaging, they put so much concern on it, *"The hardest problem is packaging, we can use environmentally friendly packaging, we tried it once because the consumer requested it, we tried to come at the plastic company, but they are unable to make that" (O-1)*. One of the problems that Case O face that most of their products are vacuumed. If it is vacuumed that it will be hard to detach, so we failed to use the one that's more environmentally friendly packaging. The same thing goes to styrofoam box, where at this time there is no replacement because that is the only material that can maintain the temperature so as the products do not spoil quickly.

5.1.3 Downstream supply chain

CASE P

Internal operation in waste prevention

Case P explained that they are an established company. They have a detailed procedure that governs the internal process from determining specifications, handling, forecasting demand, processing food to derivative products, and disposal. Case P explained in detail, *"we are an established company […] There are procedures, there are all kinds of specs. From the supplier to the entry, handling starting from receiving the goods, the display, and the withdrawal policy, how long is the product on display, even the processing book we have made, we want this product to be. Even the derivative items per item can be value-added. It can be a downgrade; the value goes down. Until the end, it was waste, so waste is not suitable for display, not suitable for consumption, according to our rules." (P-1).* The firm thereby corresponds with **waste elimination, cascades orientation,** and **economic optimisation.**

Perfect specifications are vital for case P for marketing and differentiation with other retail and traditional markets. *"If they [consumers] find the products are below their specifications and observe that consumers are not likely to buy them (illustrated in Figure 32)"(P-1)*. They further argue that products in perfect specifications are not easily damaged, although they have become relatively relaxed in some situations, e.g., when shortage due to the season. Case P explained that the suppliers to follow our regulation of fresh produce. *"Yes, we arrange a delivery schedule. They sent in the morning, especially leafy vegetables. Some use refrigerated cars, at room temperature, some are frozen, there is a loading dock itself separate from non-fresh products. So, if the product is fresh, the product is sensitive, it must be a priority. The name is risk prevention which checks the temperature according to the standard. If it does not comply with our regulation, then we usually reject it straight away. For example, the freezer does not 18 degrees, minus from there they are immediately rejected." (P-1).* As such, **maximisation retained value** is exhibited.

Figure 32 Example of food waste

Collaboration in the supply chain

Case P explained that in their business process not only receives product from suppliers, but they also provide various approaches and educate them to build good cooperation and improvement. Information sharing is an essential factor in a company's development. Case P revealed that the information they received is mainly from the Head Office. *"From HO, but we also give input too. We observe consumer behaviour, we provide input such as our competitors already like this or like that, or outside like this." (P-2).* The role of government is inseparable from the company's overall business, ensuring the company comply with food safety regulations and the Indonesian Ulema Council for halal certification. Case P explained, *"the government continuously trains the way of good food retail. There is also MUI for halal certification, right?" (P-1).* That role and their support are needed in building a sustainable business, which aligns with the principle of **leakage minimisation**. The company at this time also joins in the association of the Indonesian retail (APRINDO).

Since 2012 the case P no longer provides free plastic bags for customers; since then, this has encouraged customers to bring their own shopping bags or buy 'green' bags at the stores. Responding to the problem of materials used for fruit and vegetable packaging, the respondent revealed that the company still uses plastic as their primary packaging material. However, for the plastic use, they have not made much effort yet. *"Not yet. At the moment, we make consumers pay the cashier if they ask for plastic packaging, but for the fresh produce, not yet. As for the packaging of fruits, it has not happened yet, so we still use styrofoam." (P-1).* More specifically, the respondent revealed that the firm is still dependent on the reuse of styrofoam. One of the firm's solutions, which shows **environmental consciousness,** is to reduce the use of plastic is to reduce the placement of plastic roll bags in the vegetable and fruit areas.

Technology adoption

Case P announce a partnership from a prominent lamp manufacturer in promoting the concept of environmentally friendly retail which can significantly save energy consumption. They have been chosen as the first project to showcase this collaboration. In addition to creating an environmentally friendly shop, saving on expenditure is also one of case P targets. *"We are conducting a survey to determine the optimum air conditioning temperatures for visitors." (P-3).* Every year, they also support the Earth Hour by turning off the lights for 60 minutes. Not only that, but case P has also begun to open the roof of its outlets to capture natural lighting. Thus, electricity consumption for lamps can be reduced. In 2020 the company's side targets are to be able to save energy consumption by reaching 30% saving. *"As we now have 82 stores, the savings are equal to free electricity consumption in 25 of them," (P-3).* This case also uses digital technology like WhatsApp for demand data sharing with growers and distributors, which shows **waste elimination** and **economic optimisation**.

Social orientation

Case P in implementing **social responsibility** is managed by the corporate and centralised in the company as they have a foundation (as illustrated in Figure 33). Through the secondary data from the company's website, P makes a breakthrough by providing special needs to work in their stores. The company is cooperating with the Social Department of Cibinong Bogor to employ special needs in the cashier area and customer service.

Figure 33 Website of to share CSR information (Source: Case P company website)

Barriers in adopting Circular Economy

The respondent explained that they could not make flexible specifications. Except there is a disruption, for example, dry season, the product specifications could become less flexible.

"Actually, there is not flexibility of specifications, but we have realised this is a natural product, for example, like yesterday, it's sweet potatoes. This sweet potato two weeks ago didn't qualify because it was too small. But in the end, we accepted that and sold below our usual price, it will become cheaper " (P-2). The company sells at a lower price those products that slightly deviate from their specifications. They still assess if a product is not suitable or far from the specifications and if that is the case, they will reject it. *"But yes, we still look at it, even when it's a bit off the specification, but if it seems as if the consumer will not buy the product, we will reject it." (P-2).*

CASE Q

Internal operation in waste prevention

Case Q argues that specifications are the key to waste prevention. They set to make sure that only high-quality products will be offered to the customer as it ensures as many products are fast selling and fit the market segment. *"Yes, when they are selected, we will only take the best one following our target market. If it is below, the customers are unlikely to buy." (Q-1).* They also have forecasting demand to make sure what they order to the supplier is align with their historical sales*. "We have demand forecast, and we match in with historical sales to make sure products are sold and minimise waste" (Q-1).* This reflects **waste elimination** and **economic optimisation.**

The respondent mentioned that it is essential for waste to be recorded before discarding. *"Before they are discarded, they have to pass through some steps, i.e., weighed, recorded, and a picture was taken. They set tolerance limit of waste in the company is 5-7% for vegetables and 10-15% fruits in total" (Q-1).* In addition, this assessment includes taking into account the products' physical appearance. *"There are some characteristics. Usually, they are not fresh anymore. When we see that, they are already not worth selling for consumption" (Q-1).* The respondent added that they had received direct instructions from their headquarters in Japan that every product has to be brand new, so there is a very narrow area for derivative products as part of the commitment to customers, indicating **cascades orientation** and **economic optimisation**.

As the handling process has become one of the reasons why food waste can occur, the company considers training and giving proper guidance to employees regularly. *"We do have. It is Quality Control. It is conducted regularly every month, usually in the second week" (Q-1).* To prolong the life of vegetables, the company has invested in a showcase that contains an automated spray that can emit a thin mist continuously to keep vegetables fresh, as depicted in Figure 34. *"I think this is rarely found in most retailers in Indonesia. Using this kind of* *showcase; helps to keep products fresh" (Q-1).* The company has made some effort for the prevention of waste occurrence. While thinking about a method that could be implemented to reduce waste, they also consider delivery scheduling, sales and customer appeal as a factor *"It will be discounted usually. The discount is one hour before the shop is closed. We close at 10 pm so when the clock strikes at 9 pm, we started to discount" (Q-1).* These incentives apply to both customers and employees, and demonstrates **maximisation retained value.**

Figure 34 Automatic sprayer

Collaboration in the supply chain

Together with the suppliers and internal sales development, Case Q make innovation for product development. This including selecting packaging material, although they still depend on conventional plastic packaging. The company has intentions to change its plastic usage into a more environmentally friendly product, which displays **environmental consciousness**. *"Previously, we mostly used white styrofoam for some local fruits and vegetables, but this has been stopped because they received many complaints from suppliers regarding its usage having a bad impact on the environment in the end, we decided to use mica" (Q-1).*

In order to obtain high-quality products, the company revealed that they are considered to be very strict with supplier selection. In their procurement process, *"For distributors, there are many. They compete so they can supply their products to our company. It is our head office that makes the selection of suppliers. Especially those who have more experience. This means companies that have been suppliers for more than five or ten years have a good market share and have their farm, which is preferable. If then we see how the products from suppliers have started to decrease in terms of quality, then we do an inspection" (Q-1)*. In essence, an audit will be conducted if the company has found issues with products, especially regarding quality, a problem with supply and chemical usage, which shows **leakage minimisation.**

Technology adoption

Besides the regular electricity power, case Q installed a 500-kilowatt solar photovoltaic power plant as a power storage battery in Jakarta's malls. The respondent explained that the use of this technology could save from 5%-10% of electricity consumption. As mentioned as a method of waste prevention, a showcase equipped with an automated spray is used by the company to prolong the life of vegetables and keep them fresh. *"Using the automatic sprayer of showcase; it really helps to keep products fresh" (Q-1).* They also using digital technology adoption such as website to increase sales and social media to build relationship with supplier and growers which reflects **waste elimination** and **economic optimisation**.

Social orientation

A series of events called "Farm to Table" is supported by case Q. These events are presented as an exhibition of a variety of fresh local fruits and vegetables, which aims to educate the public about the importance of a healthy lifestyle. These events also show consumers that growing vegetables can be done at home, with limited land, through urban farming methods such as microgreen and aquaponic. As a provider of lifestyle needs, the company is committed to becoming an environmentally friendly retailer. A tree planting action is the first activity in a series of other environmentally conscious campaigns that it will consistently carry forward (see Figure 35). The company hopes that the existence of the mall that begins with tree planting will further increase the ecological awareness of the community, thereby presenting **social responsibility.**

Figure 35 Website to inform Tree Planting program (Source: Case Q company website)

Barriers in adopting Circular Economy

The respondent explained that waste is unavoidable, with the handling of products being the most significant contributor. *“It starts with the handling. From the beginning, if the loading and product receiving process is done carelessly, it will become the biggest waste contributor in the company. There is a need to keep the commitment of the employees” (Q-1)*. In response to the possibility of selling items that are below specifications is difficult because consumers are used to buying the perfect product, so they go to modern retailers.

CASE R

Internal operation for waste prevention

To prevent products become waste, Case R explained the importance of forecasting the time when consumers visit and the implications to purchase order. *"First, we can adjust the display capacity according to the crowd level from the display area. When the shift gets crowded, we will make it a full display. This relates to our purchase order to suppliers. We even adjusted daily. Thus, it allows fast selling and limits spoilt produce. We then add pads and or bedding to the display to reduce harsh contact between fruits and vegetables. We check it all the time, re-arrange the display" (R-1).* Another prevention method is to spray the product regularly with water, depending on the type of product. *"The treatment is that we spray them with water, and we put them in the cooler showcase. We have a misting device for automatic spraying, or we spray manually with water (see Figure 36). We also use air conditioners here; however, the important thing is product knowledge; not all vegetables require much water as it causes them to wither easily, that is why training is important" (R-1).* These actions exhibit **waste elimination** and **economic optimisation.**

Figure 36 Automatic sprayer

Case R implemented **cascades orientation** and **economic optimisation**. They process food before they classified as breakage. First, they will observe how much of the product is damaged; if it is not severe, they will process it, having cut out the inedible part. *"We cut out the bad part, then the rest that's still good and edible we will make into processed food, such as sliced fruits, salad, rojak, also juices" (R-1).* The respondent added that they also set up a special area for discounted products for specific fruits and vegetables near expiration, as shown in Figure 37. *"That also becomes one of the solutions, because the level of damaged product is already 5%, so high. So, putting them out as discounted can be one of the solutions to decrease the amount of breakage; for instance, we have dedicated a special shelf for discounted products" (R-1).* The discount method aims to decrease the amount of breakage, even though it will decrease the profit.

Figure 37 Discount for reducing food waste

Collaboration in the supply chain

The company revealed that to ensure quality and continuity from its suppliers, they conduct yearly visitations. "*Yes, we do that, but it is usually when the supplier registers with us for the first time. Currently, we review them once a year" (R-1)*. The respondent stated that they are considered to be very strict when it comes to the specification; they do a daily audit at the beginning to make sure the supplier has the capability to deliver a quality product that is accompanied by continuity. The company visits the grower to observe some critical aspects, such as product availability, the production process, the soil quality and the system they use. "*In the beginning, when they register, all the requirements must be completed. We check where they do the production, how big is their land, are they own it themselves or collaborate with grower groups. We usually check all of them. We have an internal audit every six months for product safety purposes*" *(R-1).* The excerpt therefore suggests actions of **leakage minimisation.**

The respondent explained that there is still plastic and Styrofoam use. It is due to the process of bulk purchasing that still depends on the plastic bag. Overall, the company has tried to follow the government regulation regarding plastic usage, so they have provided some reusable shopping bags and cardboard in the store to end up using these instead of plastic bags, exhibiting **environmental consciousness.**

Technology adoption

The respondent said that the company depends on electricity and is not using other renewable resources in their business. *"We are in the mall; we rely on the mall operator and what energy they use; I think they use diesel for backup" (R-1).* Case R clarified that their retail location is in the city, and the supply of electricity from the government is good. When it comes to technology usage and development, the respondent revealed that the company has always been open to the application of technology in the store. For example, with the emergence of online shopping today, Case R immediately formed a home delivery service in order to fulfil consumers' needs and new behaviour. In this case, the respondent explained that the company is able to adapt to the fast-changing environment. *"We are adaptive enough. We follow, so it's really adaptive. Regarding technology, we follow it. The market trend is now online. So, we follow it (as stated in Figure 38)" (R-1).* These actions demonstrate **waste elimination** and **economic optimisation**.

Figure 38 Website to inform CSR program (Source: Case R company website)

Social orientation

The respondent explained that zoo management wanted to use it for their animal feel, but the company refused. "*We were once asked for the waste from zoo management. Nevertheless, we did not permit because we were worried. We worried in case something might happen to the animals" (R-1).* So, the main reasons why the company finally decided to refuse was because they were worried about the animals' health and be blamed. As a form of awareness and active participation in environmental preservation and repair of degraded land, the company is collaborating with WWF-Indonesia to take concrete action to improve the Ciliwung watershed area by planting 2,000 trees. The government role is also essential in their business. "*The government does inspections usually about food safety" (R-1).* The respondent revealed that the government often makes inspection of their store for supervision purposes about food safety, showing **social responsibility** in the firm**.**

Barriers in adopting Circular Economy

The respondent continued that whether it will work or not depends on the factors of cost and consumer willingness. "*Everything is back to the matter of cost. Why? Because if we use cardboard, then the cost will be higher than plastic usage, and automatically the selling price will also become higher" (R-1).* One improvement they have successfully made is how the company uses the leaf to wrap the vegetables instead of sticky tape: *"Vegetables are also being wrapped in leaves. It also reduces plastic use" (R-1).* One of the obstacles they face is that they do not make donations for edible products; instead, they dispose for food safety reasons and prevent being misused by employees.

CASE S

Internal operation in waste prevention

Case S described several efforts in preventing the occurrence of food waste that reflects the manifestation of waste minimisation. It starts with good forecasting demand, then being very selective and strict in sorting products from suppliers to ensure the products is marketable following their target market. Case S stated that they differentiate their position as a modern retailer from the traditional market, *"so, for retail, appearance is the main thing, except for traditional market […] we try to minimise it [waste], so, the QC team is rigorous, these products that are displayed are the good ones; it is already our commitment." (S-1).* The rejected product would be immediately returned to their suppliers, *"We ask suppliers to take them [rejected products] back" (S-1).* The next attempt is by improving the handling process and understand the product knowledge, *"Because the display procedure for each vegetable is* *different. Some have to be put inside, whilst some at outside the chiller. Also, the arrangement must not be stacked or overloaded. Every vegetable has its treatment" (S-1).* Every store has to manage their products all to be sold due to non-consignment sales to prevent the economic loss, *"so the store is very careful in handling and estimating order because they have to take responsibility for it" (S-1).* This shows evidence of **waste elimination** and **economic optimisation.**

To prolong the products, they provided showcases to display in-store at the proper temperature (as illustrated in Figure 39). *"We use chillers, which are like open showcases to keep leafy vegetables fresh. We also doing manual spraying; every hour, our team checks the display and rearranges it to keep it looking attractive" (S-1).* Case S attempted **economic optimisation** and showed **cascades orientation**.

Figure 39 Showcase to prolong products with attractive packaging

Despite the attempt to recover food for derivative products, case S explained that not all products could be recovered, concerning their commitment to serve the freshness and tied with the food safety regulations as they have ISO 22000, they have no option other than have to discard the products. *"Products can become damaged due to shelf life, withered. If products are no longer worth displaying, they will be taken out to the back" (S-1).* Case S also does not deny the possibility of food waste caused by their own customers' behaviour that carelessly touches the products; therefore, they mitigate by placing people in the fresh produce area to take care and rearrange the products. Case S do not have waste management. They admitted that once the products not suitable for display, they take them out and send them to the breakage area. Waste is scaled and cutting down as breakage with supervision from security and disposed to the final dumpsite. *"I am afraid of misused. So, if it is damaged, not worth display, it will be destroyed entirely. Make sure it can't be sold again" (S-1).* Apparently, **environmental consciousness** and **leakage minimisation** are missing in the case S as they are not processing waste and do not attempt to channelling waste to use as a nutrient.

Collaboration in the supply chain

Respondent explained how they adaptive to the situation, that the company had ISO 22000 certification for food safety management. In addition to that, they have halal certification seeing the most Indonesian citizen are Muslim that guide the directions to comply with all certifications they had. *"We had ISO 22000 and add halal certifications, that's important for us […] Including the packaging, we don't use styrofoam. We moved to environmentally friendly [...] we have to adjust the trend, follow what the consumers wants" (S-1).* They also sell fresh organic produce; therefore, they required their suppliers for organic certification and did an annual audit, thereby utilising **leakage minimisation**. *"So, here the hydroponic and organic suppliers usually done a lab test, the results are given to us one a year, I have to make sure that" (S-1).*

Technology adoption

The current technology use in case S is a chiller showcase to maintain the temperature of fresh produce so as prolong the shelf life of the products. The orientation of technology is not featured in case S. Whilst it is different in digital technology adoption, it is vital to support their system and as a means for communication both with the suppliers and customers. They have realised that nowadays online market began to grow. The emerging trend suggests the need to develop the new market and improve their websites not just as part for information. *"We need to follow the trend, including developing online market (see Figure 40)" (S-1).* With so, digital technology adoption indicates **waste elimination** and **economic optimisation**.

Figure 40 Website for developing online market (Source: Case S company website)

Social orientation

The **social responsibility** of case S is to continue its focus on children's education. During 2019, it was actively involved in the "In-Store CSR Educational Fieldtrip for Children" activities at their outlets. This programme attracted children from schools nearby, where they are invited to tour the booths and receive education delivered by the employees. Important information such as basic information on hygiene, food management, the benefits of fresh products for health, and modern retail's role and function was delivered in an interactive way to the children. The company also held a new CSR programme with *Yayasan 1001 Buku (1001 Book Foundation)*, a non-profit foundation based on volunteer teams, to allow consumers to donate children's books at some outlets.

Barrier in adopting Circular Economy

Unavailable plastic wrap packaging available in the market made the case S still have to use conventional plastic packaging. *"I don't think the material is available, I don't know, there's nothing yet, but I haven't searched yet. The second, which is sure to be expensive. Which costs will be expensive […] but we will see we need to be aligned with vision and mission of the company" (S-1)*. Case S do not repurpose food to donation and unprocessed waste to the lack of trust to other parties and misuse in the internal company.

CASE T

Internal operation in waste prevention

Case T preventing waste by having an accurate demand forecast and learning from historical sales. Accordingly, they are careful in determining the quantity to order because the excess order will result in waste. Another important aspect is the product specifications to ensure the products are marketable; Case T alluded, *"We must be careful in order products to not too much. All orders depend on outselling capability. If products are still available, then we will not request more. We must be sensitive to know when it busy or not […] Product specifications is important. That is why for modern supermarkets, we have to be able to differentiate between what we sell and local markets. The quality is also different. Automatically, the supplier who sends to us, for example, the products that do not match the specifications, will automatically be returned. Everything has followed the rules." (T-1).* As such, **waste elimination** and **economic optimisation** are exhibited by the case.

Case T also try to prevent food waste by creating derivative products, Case T illustrated as reflected principles **cascades orientation** and **economic optimisation**. *"Local fruits we can still process, like watermelon, melon, papaya, we can turn them into sliced fruits." (T-3).* Furthermore, due to safety concerns, case T only limited to those items that can be recovered. Case T added that fruits that near their ripeness to be processed to be various juice *"For the juice is only for fruits. Juice is allowed, but only four hours after processing to comply with food* *safety." (T-4)*. To prevent the product from going to be wasted while still generating revenue, they offer discounts on items in the evening. Case T added *"Yes, we mark them down. For vegetables, for example, in the morning we display it, at the afternoon or evening they tend to be withered, we immediately put them into discount item 50% or buy one get one." (T-2)*.

Collaboration in supply chain

The relationship between Case T and its distributors is strong. Case T did not require their distributors to have a specific certification unless for organic products. The key is having effective communication. They measure the distributor's performance by service level, *"we make sure that we have good communication with the suppliers, we are discussing how much weight is desired for this product, how it will be packaged, and what type of packaging will be used. We should communicate everything, including delivery scheduling issues and any issues with orders that suppliers do not fulfil, a situation referred to as service level. Then we order 100, but they send only 80. Why suppliers are not fulfilling the quota, there will definitely be some kind of service level warning." (T-2).* **Maximisation retained value** are therefore exhibited**.**

Regular checking is being conducted to monitor suppliers and growers to ensure quality and continuity, although not in the term of audit as explained Case T *"usually store and supplier will visit the growers directly. Not until like audit, we just visit them. For audit, we only have an internal audit." (T-1).* As also stated by Case T they coordinate between department, merchandiser and internal auditor to appraise the performance. *"We talk to other departments, such as merchandiser, what products need in our store, talk if there is a problem. And there is also the auditor for food safety, once per year, So, if you start from the process, packaging, displaying it does not comply with food safety standards, become their [auditor] finding." (T-3)*. As supported by the excerpt, the case therefore shows **leakage minimisation.**

Technology adoption

Like the other modern retailers, case T uses the cold storage system, showcase with the refrigerator system. The application of technology associated with digital technology adoption, such as a communication system within the company. Case T mentioned how the company had applied a web system to support coordination, *"Here we use web system to communicate in the internal, just as we reported from merchandiser if we have a problem." (T-3).* Digital technology is also used to share information through social media and company websites to increase public awareness of their brands, promote events or promote their products to the broader audience (as illustrated in Figure 41), which shows **waste elimination** and **economic optimisation**.

Figure 41 Website for increasing public awareness (Source: Case T company website)

Social orientation

As a modern retailer company, case T considers that products should be discarded since all is calculated economically. There was an idea to repurpose food to be given for the community, but their rules prohibit it. Case T mentioned, *"As personally, I agree to give food as a donation. It is impossible. Because we do not have rules to do that or to get there, that too risky for our company." (T-1).* Further the respondent explained that the possible action is to give a discount so that case A still receive revenue. *"Markdown the products to 50%. That's also donation, but the term is different." (T-1).* Concerning the possibility of selling discounted items to employees, Case T explained that selling discounted items to employees is prohibited to prevent inappropriate employees' behaviour. *"Actually, if we look at the regulation, then it's prohibited to sell discount items to staff or employees because we are afraid it will be purposely put in items for the discount when actually it is still a good product. If we look at our SOP [standard operating procedure], it is not allowed." (T-3).* This thesis found information through the company website that case T collaborated with other companies to provide dropbox packaging waste for non-organic such as plastic bottles as part of the **social responsibility**.

Barriers in adopting Circular Economy

Case T is well aware that agriculture produces a lack of uniformity. The harvest quality and quantity are affected both internal and external aspects such as weather, season, pest or even particular behaviour that caused the product to get damaged, *"There is standardisation for fruits and vegetables, but it's not rigid, because it is not manufactured products, for example, cans cannot be dent or rusty. However, there is a difficult time in fruits and vegetables that* *make us less stringent so that we still can accept that. Informing them through this system so that the recipient knows that something like this will exist. But to sell the misshaped vegetables is impossible, customers may not come to our store." (T-3).* There are no substitutes for plastic and styrofoam on the market at the moment, so they must continue to use these materials. For processing waste, case T has ruled that waste should be disposed of because it is risky if used by other people and leads to poisons to damage their reputation. Hence, the principle of **leakage minimisation** is not manifested.

5.2 Summary within case

This chapter presented individual case within case analysis, in which the implementation and action in each capability strategy is explained to find out the uniqueness of each case. The themes are divided into five parts; internal operation, collaboration in supply chain, technology adoption, social orientation, and how these capabilities correspond to CE principles and continued by explaining the barriers faced in each case related to CE adoption. This establishes the foundation for cross-case analysis, in which the cases are analysed. Moreover, individual cases comparisons will be made, and the research questions will be addressed. Following that, the tables for individual case analyses are compared in order to identify patterns that can be used to answer the research question and objectives.

CHAPTER 6 CROSS-CASE ANALYSIS

In the previous chapter, a single case was analysed to identify actions and the barriers to CE adoption to ascertain the unique characteristics of each case. In this chapter, cases at different stages of the supply chain are compared and contrasted to answer the research question and accomplish the research objectives. The purpose of identifying any pattern is to gain a condensed overview of the common meanings that recur throughout the data.

This chapter is divided into three sections. The first section identifies the similarities and differences to find the general pattern of the deployment capabilities of cases and explain the relationship between the resources in the strategic capabilities of NRBV and CE principles (Section 6.1), and hence accomplish research objectives 1 and 2. Section 6.2 identifies the barriers to CE adoption to accomplish research objective 3. Finally, section 6.3 is presented to accomplish research objective 4 to propose the CE adoption framework that is contextualised grounded in strategic management theory Natural resource-based view.

6.1 Relationship between NRBV resources and CE principles in the agri-food supply chains

6.1.1 Pollution prevention

Similarities and differences in actions for waste prevention exhibited by the cases are illustrated in Table 18. The table includes categorising these actions further into a higher level of operational capabilities, grouped into five categories: planning, operational process, control, learning process, and culture, all of which indicate the capabilities within continuous improvement of the supply chain. The supply chain's actors consist of growers, distributors, and modern retailers, which provide the consequences of different capabilities regarding how firms apply internal operations for waste prevention. All cases reveal the importance of forecasting supply and demand, thus ensuring consistent supply throughout the year. The implications of forecasting involve devising a plan of production and procurement of raw materials and coordination with suppliers. They attempt to produce or order closely based on demand and ensure all products are marketable, thereby preventing waste as the short life of perishable products risks significant losses.

Although it is only exhibited upstream, as most growers use arable methods, a production plan and estimating risks are important in the projection of yields. Case H, for example, emphasises the need to understand patterns of the business process to create an effective plan, as planting is a complex process that has many implications. In particular, for growers, an essential aspect of cultivation includes the use of superior seeds as they are a prerequisite for producing quality products based on product specifications and will determine the strength in dealing with diseases and pests. Growers all realise that applying best practice cultivation is important as most know this from extensive experience. However, maintaining discipline is challenging and may result in non-optimal yields. Soil management plays a crucial aspect in planning in the upstream as it is an essential medium to produce high-quality products. As soil is a valuable natural resource, it requires preservation of its nutrients, good treatment and regenerative processes to take place. Case C had invested in recovering damaged soil due to pollutants from chemicals substance, where a long time is needed before it is ready to use.

A vast range of efforts were made to preserve the quality of products for as long as possible, in order to exhibit the principle of **maximisation of retained value,** as all cases incorporate a lean process and punctual delivery to their customers, given that products can deteriorate easily. Employee training on proper handling and understanding product knowledge is a consensus among actors to limit waste produced; for instance, to reduce damage due to the way products are arranged during harvest, delivery and display. Additionally, all cases established a logistics system. Most firms invest in a cold chain management, using refrigerated trucks for delivery, monitoring temperature and utilising coolers or mist spray to maintain the freshness of products, and scheduling delivery times. However, the cold chain management does not appear in all cases due to the varying commodities, some of which do not require a cold chain but need air circulation, as seen in Cases E and L supplying tropical fruits. Although products are to be distributed to customers almost immediately, an adequate storage system were used to support fruits, which has a longer life than fresh vegetables. While Cases C and G, which are small companies, rely on appropriate harvest time and effective delivery schedules in maintaining the freshness of products.

Both midstream and downstream set a minimum buffer stock to ensure the freshness of the products and minimise waste. Maintaining the freshness of the products has implications for upholding the high value of products; hence, firms will attempt to optimise its economic value. Firms also take control to ensure **economic optimisation** by only accepting high-quality products based on the specifications book by using a strict sorting process to fulfil consumer demand. The midstream compensates this by providing a support team to assist growers in keeping to desired specifications and giving advice on how to achieve them. Moreover, the capability to orchestrate the flow of products from upstream to downstream is crucial. This means not only does the freshness of the products has to be preserved, thus reducing the risk of rejection, but a commitment service level towards downstream are also maintained.

The two main types of growers are in the form of a corporation and a cooperative that consists of a group of growers. The former is more regulated and supported by several divisions in their operations and concerns more about financial losses caused by waste, which prompts them to implement waste prevention measures in their standard operating procedures (SOPs). This can be observed in Cases A and J and similarly identified in one particular distributor and modern retailers. Breakage items allowance is also incorporated as one of the key performance indicators (KPIs) revealing maximum tolerable limit. This thesis found that seven cases (A, J, K, P, Q, R, S, T) utilised KPIs as the measurable value to prevent waste, to evaluate intended results and what needs to be improved. Whereas other cases in the form of groups of growers and small corporations take less care on measuring and recording the amount of food waste. This is because they focus more on productivity that will compensate for loss, resulting in insufficient data for evaluation. Even so, it seems that other actors does not have a standard measurement of waste control, with the general practice for growers referring to good agriculture practice (GAP), and distributors' control measures are primarily undertaken at the growers as part of a partnership; i.e., growers only deliver products that meet retail specifications.

Continuous improvement enacts five CE principles: waste elimination, economic optimisation, maximisation of retained value, environmental consciousness, and leakage minimisation in different degrees. The main principles of CE, which are predominantly demonstrated in all cases, are the elimination of waste. This shows how the company strives to continuously learn at every step of the process and benefit from accumulated experience. The internal learning process is supported by higher learning through stakeholder integration. The outcome of **waste elimination** and **leakage minimisation** is the reduction of FLW. This thesis identifies all cases (A to T) demonstrating successful waste reduction by improving their internal process. For instance, case A strived to develop their internal process as they are aware that waste means economic loss, including time to grow, cost of labour, and material used. One way to prevent loss is by early detection of suboptimal growth of plant and cutting them off, similar to Case C's method; however, this practice is not common in other growers. Leakage minimisation, on the other hand, refers to efforts taken to limit nutrient loss during the cultivation process and preventing hazardous substances from entering the environment. The manifestation of **environmental consciousness** and **leakage minimisation** appeared in upstream in the way they use natural fertiliser and refer to global agricultural practice (GAP); they claimed that it would preserve natural resources. These cases were aware that applying too much chemical substance would damage the soil as a natural resource and leave a high residue in the products. Although not as prominent, it was found that firms' culture in fact, takes part in waste elimination, as exhibited upstream. Their strong commitment serves as a foundation that guides firms to prevent waste and produce high-quality products as requirements of their primary market.

Table 18 Operational capabilities of pollution prevention and CE principles

Pollution prevention (Strategic capability)	Operational capabilities	Actions	CE principles	Case																			
				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Continuous improvement (Resource)	Planning	Forecasting supply and demand	Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Production planning based on demand	Waste elimination	X	X	X	X	X	X	X	X	X	X										
		Order management												X	X	X	X	X	X	X	X	X	X
		Product specifications book												X	X	X	X	X	X	X	X	X	X
		Soil management	Leakage minimisation	X	X	X	X	X	X	X	X	X	X										
		Delivery scheduling	Maximisation of retained value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Operational process	Applying FIFO system	Waste elimination											X	X	X	X	X	X	X	X	X	X
		Inventory management												X	X	X	X	X	X	X	X	X	X
		Cut off system		X		X																	
		Improving facility		X			X						X	X	X	X	X	X	X	X	X	X	X
		Use superior seeds		X	X	X	X	X	X	X	X	X	X										
		Proper handling		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Minimum buffer stock												X	X	X	X	X	X	X	X	X	X
		Lean process	Waste elimination Maximisation of retained value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Applying integrated pest management	Leakage minimisation		X	X	X	X	X		X	X	X										
		Non-chemical pesticide		X		X		X		X													
		Appropriate harvest time		X	X	X	X	X	X	X	X	X	X										
		Cold chain management	Maximisation of retained value	X	X				X		X	X	X	X		X	X	X	X	X	X	X	X
	Control	Applying standard operating cultivation procedures - refer to GAP	Leakage minimisation	X	X	X	X	X	X	X	X	X	X										
		Waste prevention	Waste elimination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Intensive supervision of cultivation	Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
	Learning process	Understanding product knowledge	Waste elimination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Learning from stakeholders		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Accumulated experience		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Understanding agro climate	Waste elimination	X	X	X	X	X	X	X	X	X	X										
		Training for proper handling		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Training for quality control																X	X	X	X	X	X
	Culture	Implementing company value	Environmental consciousness	X		X	X																
		Strong commitment reduce waste	Waste elimination Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

6.1.2 Product stewardship

Table 19 presents the capability of product stewardship and suggests how firms collaborate in taking care of products at the level of supply chains. The actions are categorised into seven operational capabilities: securing raw material, coordinating, learning, food safety compliance, using sustainable material, product development, and food waste mitigation. As mentioned above, with different types of firms within the supply chains, there are also different ways of procuring raw materials; nevertheless, all cases communicate with suppliers to secure raw materials. Other types of firms, i.e., in the form of a corporation, have an SOP. A wide range of actions appeared from procurement and coordinating, involving fluid communication across functions, collaborating to secure raw materials internally and externally. In the upstream specifically, a demo plot with seed, fertiliser, and pesticide suppliers was created to ensure that firms can produce the highest quality products whilst eliminating as much potential waste as possible. The most critical aspect for distributors is maintaining commitment to customers by supplying the products according to specifications. Therefore, most distributors secure their supply by building a relationship with growers. Partnership with growers is established and maintained at the midstream level to further observe the quality and availability of products.

In addition to regular visits across all levels and communication with retailers, demand in data sharing between different types of firms is made with the aim of coordinating, hence allowing **economic optimisation**. This is seen in the firm type of group of growers, where they attempt to sufficiently fulfil organic fertiliser and seeds requirements by empowering members to make/grow their own. This type of firm has frequent meetings to coordinate with members to make a production plan, have collective problem solving and maintain a close relationship with the government who provides assistance. Case O, for instance, established a partnership and strictly supervised the growers to handle responsible sourcing for big companies. In addition, they assisted and monitored growers regularly to ensure that growers comply with the rules set by distributors.

Within stakeholder integration, most cases actively collaborate with other stakeholders in their learning process to improve knowledge, such as collaborating with universities. Cases also collaborate with international non-government organisations (NGOs) for transfer of knowledge, introducing new variants, and technology. The process of higher-order learning involving stakeholders contributes to better internal operations in the pollution prevention strategy. Product stewardship also suggests responsibility for food safety compliance as it is a critical aspect of the food system. Several regulations, including those imposed by the government, and a growing awareness of food safety have resulted in more cautious practices. Furthermore, several cases obtained certification, such as organic, local government certification, ISO and halal, as an assurance to consumers of their food safety, as exhibited by Cases A, B, D, E, F, J, and S.

In terms of sustainable material, common ground is found between all firms, where reusable crates are used to transport produce, with some also using cardboard boxes as an environmentally friendlier option. The use of sustainable plastics packaging has only appeared in Cases A and D, which have shifted to recyclable plastic packaging. Similarly, Case D has begun to replace conventional plastic with corn-based plastic due to customers' requests and assistance from an international NGO who has long collaborated with them. Case S plans to use sustainable material by replacing plastic wraps with banana midribs to wrap their vegetables. All modern retailers (Cases P, Q, R, S, and T) have reduced the use of plastic bags but are unable to eliminate and fully replace conventional plastic for packaging. Retailers admit that plastic packaging is also disposed of along with breakage products into the rubbish bins without separating the plastic. However, the material of packaging is unsustainable and causes another waste stream to emerge. Despite this, to the best of retailers' knowledge, sustainable packaging is still not economically viable according to cost and benefit analysis, availability on a large scale, and its insufficient durability to protect the products. Although retailers admit they are just the user, they expressed a positive view in being willing to change if suppliers could provide a more affordable sustainable packaging.

It is found that intense communication between chains occur during product development in order to meet market needs. New product development initiatives often come from retailers, as they frequently interact with end consumers and conduct internal market research to remain updated on trends. In addition to maintaining communication, retailers conduct continual visits to suppliers and growers to help monitor and secure supply. This shows economic optimisation whilst eliminating as much waste as possible through the prevention of changes in product quality. However, it is worth noting that product development is limited to economic optimisation and has yet to reach the stage of developing more environmentally or even discussing product design based on a life cycle approach.

Collaboration in the supply chain in product stewardship also mitigates food waste throughout the end-of-life products, which represents cascades orientation. An array of cascades' actions has been demonstrated to optimise the economic value of the products in descending order. For example, there is a common practice of supplying products to several distribution channels in the upstream and midstream. Some growers have vast farming areas and have attempted to expand their market, giving them higher value and price certainty as they are able to export their products. From this, they claim that the modern market has limited capacity. As admitted by cases F, H, and I, cascade appearing in the upstream and midstream through diverting suboptimal produce to traditional with less stringent specifications are not always favourable due to lower value of products and volatile pricing. The cascade's actions at the upstream level are longer than other supply chain stages, suggesting flexibility to optimise economic value. All cases in the upstream and midstream explained that they give the products that are still edible to their employees and community as most firms prioritise economy first. However, donations are made only in some circumstance of surplus production or leftovers that are still edible after sorting products. Other forms of cascade actions shown by both the upstream and midstream uses food waste for animal food and composting. Cases A and G, however, does not process waste for compost because they do not need that type of compost.

Even though similar practices are demonstrated in the upstream, food waste mitigation is not as flexible in other supply chains and has shorter cascade actions. Food waste mitigation has been incorporated in SOPs, such as re-packaging products, which can be used for derivative products, and are under strict supervision by the food safety control team. Economic value is also optimised by promotions due to revenue reduction. One mitigation effort is demonstrated by one of the retailers (Case R), where nearly expired products are offered at a discounted price in a special corner in the store instead of being disposed of right away.

One compelling finding reveals that modern retailers have prohibited any food donation. Instead, they strictly follow the feasibility of products measured based on their physical appearance rather than their predicted expiry date; this results in products being put in the breakage bin and into landfill. This is primarily due to distrust built between companies and target donations. Despite several attempts that retailers made to donate products no longer fit for display but still suitable for consumption, the system was eventually found to have been exploited and used for individual gain, i.e., through re-selling.

Stakeholder integration is the resource of product stewardship, with its most prominent principle being economic optimisation. Therefore, these indicating supply chain actors seek to exploit stakeholder integration for the purpose of economic optimisation. Although higher-order learning does not directly relate to CE principles, it is certainly beneficial for the firms' internal operations.

Table 19 Operational capabilities of product stewardship and CE principles

Product stewardship (Strategic capability)	Operational capabilities	Actions	CE Principles	Case																			
				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Stakeholder integration (Resource)	Interorganisational cooperation	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination	X	X	X	X	X	X	X	X	X	X										
		Partnership with growers/suppliers												X	X	X	X	X					
	Information sharing	Demand data sharing	Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Regular meetings with grower members			X		X	X	X		X	X											
		Regular visits		X	X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X
		Communication with retailers		X		X	X		X	X	X	X	X	X	X	X	X	X					
		Intense communication with customers and suppliers for product development and new variants		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Communicating with suppliers		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	High order learning	Strong relationship with government			X		X	X	X		X	X					X			X			
		Learning from other networks and associations	Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Support from universities for innovation			X		X		X		X			X		X	X	X					
		Comparative study abroad		X			X	X	X		X		X	X		X		X					
		Transfer of technology and knowledge from international NGOs			X		X		X		X												
		Technical support from manufacturer (seed, pesticide and fertiliser)		X	X	X	X	X	X	X	X	X	X										
	Food safety compliance	Certifications (GAP, Prima, organic, ISO, halal, HACCP) , audit internal and external	Leakage minimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Using sustainable material	Using recyclable plastic packaging	Environmental consciousness	X			X																
		Reusable crates		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Cardboard box		X		X	X				X	X	X	X	X			X					
	Product development	Collaboration with a nutrition expert	Economic optimisation			X							X										
	Food waste mitigation	Distribute below-specification products to other channels	Waste elimination Cascades orientation Economic optimisation Maximisation of retained value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
		Processing food for value added products/derivative products		X		X		X								X			X	X	X	X	X
		Re-package		X									X						X	X	X	X	X
		Promotion																	X	X	X	X	X
		Waste for animal feed	Environmental consciousness Leakage minimisation	X	X	X	X	X	X		X	X	X	X	X		X	X					
		Waste for compost			X	X	X	X	X		X	X	X										
		Collaboration with state-owned company in waste management							X														

6.1.3 Sustainable development

The third strategic capability is sustainable development which consists of two aspects: technology that can reduce environmental impact and the social aspect that refers to how firms could help the poor. Table 20 illustrates the current low technology adoption. As the arable method is prevalent, most growers rely on simple tools as advancing technology is considered unappealing to firms due to the high cost of investment. However, some cases showed that the use of technology is beneficial for them. The current technology adopted by growers include greenhouses, drip irrigation and nutrient film technique (NFT) systems, but they only appear in four cases (A, D, H, G). These technologies are claimed to reduce water use and the risk of crop failure caused by weather, pests and diseases. The adoption of technology is clearly linked to the CE principles of **waste elimination** and **leakage minimisation**. The growers admitted that they could obtain higher yields compared to conventional techniques and have access to safe water use, resulting in reduced FLW and preserved natural resources.

Some technology adoption entails utilising ozone filters and wastewater treatments to ensure food safety and treatment effluent, as well as reduce FLW and leakage minimisation by using technologies, such as conveyor sorting machines and wrapping machines to accommodate human error, and conventionality to maintain the quality of the products. Additionally, distributors have recently invested in processing machines to prevent waste and maximise retained value as products no longer fitting specifications can now be processed to derivative products.

Another technology adoption involves processing food into new products, such as processing fruits into preserved juice, crisps, or paprika, and canned food as value-added products. This exhibits the principle of **maximisation of retained value** and **cascades orientation** in Cases C and F. Modern retailers also perform simpler food processing to make derivative products. Through this process, growers and retailers align with the principle of **economic optimisation**. However, other cases still only focus on fresh commodity produce and has yet to incorporate processing food for sustainable development.

The emerging theme commonly shown in technology adoption is digital technology adoption that contributes to the information flow and learning media. Smooth information flow helps growers make quick decisions that can contribute to waste elimination. This is demonstrated by Case A who coordinates with its task force in other departments to push selling before products degrade in quality. Cases D and I, on the other hand, explained that some growers developed an application system for wireless irrigation to control remotely. Similarly, Case F has application software by collaborating with local government to access price information. Another use of digital technology adoption is beneficial for the learning process is by accessing social media, all cases can constantly update their knowledge for better operational systems and trends, thereby facilitating firms.

In terms of the social aspect at the downstream and midstream, this thesis found that social collaboration appeared in how they empowered the community involved in the business and their welfare. Particularly in the group of growers, this includes processing manure for fertiliser, so members become sufficiently independent in producing seeds and fulfilling their needs from internal members. Furthermore, case I plans to make agro-tourism a means to educate the community by introducing agriculture and supporting green hospitals by creating farming in the hospital to reduce greenhouse gas emissions. The principle of **social responsibility** is presented here as the possibility opens up employment, leading to community welfare as an outcome. In a like manner, case C commented that by empowering and involving the residents nearby, farming supports the economics of local people. In the case of distributors, they aim to create and maintain connections to growers, retailers and potential customers through adopting digital technology that allows faster and more conventional communication, such as websites, social media platforms and applications. Empowerment in the community is also maintained through community involvement and growers' welfare.

As modern retailers have strict regulations for food donation, they prefer to give other social contributions as a means of social responsibility and sustainable development. Case P provides opportunities for people with special needs, such as people with visual impairment, hearing impairment, intellectual disability, physical impairment and learning difficulties, to work in their stores. Whereas case Q provides training and education programmes for employees, as they also care about their welfare. A respondent from Case Q said, "*The company provides a range of training for employees who want it, such as training for grade promotion*." As a form of awareness and active participation in environmental preservation and repair of degraded land, Case R collaborates with WWF-Indonesia to take concrete action to improve the Ciliwung river watershed area by planting 2,000 trees through involving local community groups. In 2019, Case J was actively involved in the "In-Store Educational Fieldtrip for Children" activities at their outlets. This programme attracts children from schools nearby, where they are invited to tour the booths and receive education delivered by the employees.

Table 20 Operational capabilities of sustainable development and CE principles

Sustainable development (Strategic capability)	Operational capabilities	Actions	CE Principles	Case A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Shared vision (Resource)	Technology adoption	Greenhouse	Waste elimination	X			X		X	X		X											
		Conveyor sorting machine						X					X	X									
		Wrapping machine											X	X			X	X					
		NFT	Leakage minimisation	X			X			X													
		Drip irrigation		X		X	X		X			X											
		Ozone filter		X													X	X					
		Drone for pesticide application							X														
		Sprinkler							X			X											
		Cold storage	Maximisation of retained value	X			X		X		X		X	X	X	X	X	X	X	X	X	X	X
		Showcase chiller																	X	X	X	X	X
		Automatic sprayer																	X	X	X	X	X
	Food processing	Technology for food processing				X			X										X	X	X	X	X
	Waste processing	Chopper	Environmental consciousness					X															
		Wastewater treatment		X			X			X								X					
	Future orientation to advanced technology	Photovoltaic								X													
		Indoor system with automatic temperature control		X																			
		Automatic packer											X										
	Digital technology	Wireless irrigation system	Leakage minimisation				X					X											
		Digital technology adoption websites, apps, and social media	Waste elimination Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Social cohesion	Community involvement in the business	Social responsibility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
		Growers' welfare			X	X	X		X		X	X		X	X	X	X	X					
		Corporate social responsibilities (Earth hour, charities, reforestation, global green hospital, agro tourism, food donation)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

6.2 Barriers to the adoption of a Circular Economy in the agri-food supply chain

This section describes the barriers to CE adoption in the agri-food industry to accomplish research objective 3. Identifying the barriers to CE adoption being more circular is critical to understand the impediments that disincentivise firms' actions towards implementing changes. The barriers are classified into five main categories: knowledge; structural; financial; lack of awareness of the environment, supply chain, and technology; lack of government support and culture, as depicted in Table 21. All cases admitted that they have a lack knowledge regarding the CE; they had rarely heard the term and does not know how to implement it. However, for the upstream, CE has been associated with integrated farming, combining agriculture and animal husbandry in one location. This thesis uses a structural barrier to refer to the obstacles that are beyond individual control. Another barrier is perfect product specifications, resulting in the general assumption that only perfect product specifications are acceptable to consumers. Thus, suboptimal products are perceived as waste; however, it is practically impossible for agricultural products to even have a uniformity.

The structure barriers that only occur upstream are land contour, weather, seasonal factors or remote locations. These conditions make for ineffective waste elimination. The application of technology within agri-food technology is found to be sparse in Indonesia; two issues related to the application of technology are capital constraints and the hilly contours. Most of the type of crops planted by growers are horticultural, which many are not indigenous plants of Indonesia. As Indonesia is a tropical country with high temperatures, one possible way to cultivate these horticultural products is on high land, which resembles their natural habitat and allows optimum growth conditions. As the land used often has a 30-degree slope, growers still rely on traditional and simple tools. The use of advanced machinery deemed to make processes more efficient therefore becomes not applicable due to the size of the land area available for cultivation and the contour of the hillsides.

This brings implications regarding what are considered essential resources as each company requires different needs, resulting in the use of technology that can vary for each company. A similar issue is faced with the application of new technology and innovation. The representative of Case B reveals that, "*Actually, we can use a machine, but in considering its ability, the terrain is a bit tilted, this area is small, although from an efficiency level it is better to use a machine*." Sharing the same view as Case I that also experiences land contour issues.

The grower's knowledge to capture the value from waste appears in all upstream who have recognised the potential value of food waste for composting, but some does not have the resources to process food waste. They know that food waste needs to be processed before being made into compost; in this sense, they have the knowledge but are restricted from executing further actions. Another constraint is that not all waste from the growers could be processed for composting due to the potential for contamination of the soil by disease, leaving the only option to bury and burn. Firms seek opportunities for value creation through the supply chain link to process food waste, which facilitates and supports product innovation as there are underlying motivations to also possibly create derivative products. Internal teams of firms attempt to solve these problems to reduce waste. So, an initiative from the internal team is made to look at new opportunities, and to then collaborate with other organisations that are more proficient in reducing and managing waste. This research also highlights that many actors have perceived that organic waste is not harmful; this could be because their proximity to the natural environment means that what they do is not considered to have detrimental impacts on the environment. It appears from the response of most growers that they put waste back into the soil, assuming it would decompose by itself, without considering further complications of such practice. Indeed, bad practice leads to pollution that in the long run will prevent the company from being environmentally friendly; agriculture actually causes a lot of environmental damage, such as producing greenhouse gas emissions and methane, and even disease which will contaminate the soil.

This thesis found the paradox of the stringent specifications of retailers, who claim to prevent waste, yet are the main cause of waste for growers and distributors. Retailers' policy in terms of specifications and refusal to distribute food waste to other parties are the main barriers to adopt a CE in the agri-food supply chain. Their policy has made them less dynamic to change and assess the situation, as they are concerned more about preventing a negative reputation for their business. Moreover, business continuity has been sought as an obstacle to establish relationships with third parties, such as charity for food redistribution. This is due to a lack of trust with the third party after firms' previous attempts to donate and concerns about public health and safety issues through food donations that could also result in financial loss for retailers. Another issue is the need for safety compliance, where firms admitted that they have strict retailer audits, both internally and externally. From the retailer's perspective, the prioritisation of financial over environmental considerations is a factor that means disposal to landfill is an acceptable solution. Additionally, the misconception of environmental impacts are caused by what should be done with organic waste, resulting in improper waste management and low awareness; as a result, the potential value of waste is not recognised by downstream in the supply chain.

Barriers to the adoption of CE emerged from internal and external firms. In the case of growers, their level of capital becomes a constraint, as there is a low level of understanding about how to manage food waste to become nutrients or used for other purposes at the grower's level. This is seen in Case A, where a lack of knowledge about how to process waste becomes a barrier. Despite having awareness, they do not have the required knowledge to prevent food loss and manage waste to maximise its value and utility.

Low awareness of customers about the environment also becomes a barrier to creating new products that are derived from food waste. Because food waste is a sensitive issue, retailers have to be prudent in implementing the value creation strategy, unlike in developed countries where customers have higher awareness and are therefore willing to buy food from waste that is safe for consumption because customers perceive it as still having value. Although customers' perception is not the main topic of this research, its importance should be noted because it has implications for retailers. As such, large-scale structural interventions are needed to change customers' mindsets about imperfect products. Although perfect specifications have long been in the customers mind, this is seen as unsustainable as the implications of perfection mean wasted resources. Even though stringent specifications are part of the modern retailers' selection process, consumers are persistent in having the option to select, resulting in waste for retailers. Additionally, the absence of contract farming is one of the obstacles for growers to have certainty of price and supply, as their relationship to other chains is only transactional.

Despite the awareness of the actors of the global issues regarding plastic use, this thesis did not find any real movement towards changing to sustainable material. Reasons for this include unavailable replacement and technical issues that are currently only viable using plastic, such as vacuum packs and costs. The role of packaging is to protect the products so they are not easily damaged and to prolong the life of perishable products. Yet both growers and distributors state that the incentive to replace plastic packaging depends on the consumers' demands and is thought to incur a higher cost than the conventional plastic currently being used. This thesis has discovered that the majority of actors have high motivation to change direction towards a lower negative impact on the environment and to be more sustainable, but the unavailability of supporting materials in the market makes them unable to use materials that support environmentally friendly programmes. For example, retailers have no choice but to use plastic and styrofoam as there are currently no suitable replacements in the market.

This research points out the importance of improving collaborative and information transparency between growers, distributor, and retailers. Through visibility of the demand and traceability, growers can optimise production planning and effectively use resources. High investment in future technology or advanced technology is considered to be a barrier to implementing CE in the agri-food sector at the growers' level. Take, for example, the response from Case D. They admitted to having difficulties in managing waste because of a lack of capital, and hence prefer to focus on the improvement of good plantations rather than investing in managing waste.

Furthermore, the low cost of labour is one of the reasons that human workforce is used heavily along the supply chain from growers to distributor and retailers; therefore, the common practice is labour intensive. Compared to investment in machinery or other technology measured by the return on investment, labour serves more economically viable. Case K, for example, do not use machines in the packing and sorting processes as they argue that humans are faster than machines, and that there is a lower failure rate compared to using machines. Another low adoption of technology, such as using greenhouses, is also confirmed by Case L, who stated that they could not support their grower partner in investing in greenhouses because this causes high operational costs, and as a result, their prices cannot compete with those of imported fruits. Firms also believe that the application of technology does not significantly impact the quality and physical appearance of the fruits.

Product stewardship is the key to implementing CE, which entails good communication and coordination within the supply chain and external stakeholders for product design. However, this thesis is limited to coordinating in the interest of economics and has not yet progressed to value creation based on environmental concerns. This is because there is less coordination within the supply chain to at least provide the necessary support. The aim is zero waste and to minimise leakage out of the system by completely implementing reuse, recycling or composting of all materials. This research found that at the grower level, efforts have been made to reuse the agriculture waste as compost, however, there is a missing link in modern retailers to distribute waste to other channels as useful material for composting. This suggests the lack of support from all actors within the supply chain and that the relationships are limited to transactional relationships; hence actors cannot grasp the potential for further development or cooperation.

This can also be based on several factors: lack of communication between the various parties, ignorance or lack of knowledge about the importance of protecting the environment and minimising waste, and the difficulty of building collaboration across the supply chain because of the low interest of each party. Although group dynamics occur within organisations, many members cannot commit to a group, and one respondent admitted that managing "humans" is not easy. As stated by the head of a group of farmers (Case B), there is a changing function of organised farmers groups, i.e., only as facilitators for the government. There are dynamics within the group, but informant 2 stated that this is natural as one of the consequences of human interaction. Similarly, Case C involved the local community as part of their employees.

The role of the government is very important in realising a CE to be fully implemented. The empirical data often mentions limited land ownership, land mapping based on comparative advantage and transparency in demand. Land mapping and transparency of supply-demand, or information access to real demand, are needed so that growers do not experience a price drop because of surplus production. Land mapping refers to the core competence of the area to produce a particular product. Growers can have production planning by knowing the market demands, as stated by Case D, "*I think the demand is that much, but growers do not know, so they only produce without knowing how much the real demand is, and sometimes experience falling prices.*"

Another crucial aspect that becomes a hurdle is price uncertainty, which often creates difficulties for growers. They hope that there will be a minimum selling price that needs to be determined by the government so that growers do not experience too much loss, especially considering horticultural products are perishable and are widely planted in the highlands, which poses a greater risk compared to food crops. According to the growers, they have not become creative because of this, i.e., to think beyond their routine, because they struggle with the uncertainty of prices and markets. So, any of the matters relating to the environment are not their primary concern. As informant D suggests, "*being growers is not easy, they have so many complex things that they have to manage*." This suggests a reluctance to change and to adopt a new system.

The government was also expected by the supply chains to provide clear guidance and certification that will have implications for sustainable practices. This must be done not only to encourage growers to obtain land registration and packing house certification but also to assist in the process of acquiring that certification. Assisting the growers is considered important because growers face various issues and therefore should not be burdened by a long administrative process, as explained by Case D. The Indonesian government, through the Ministry of Agriculture, has created a certification, namely the Prima certification for quality assurance for agricultural products. This certification acknowledge that business actors have fulfilled the requirements in implementing a food quality assurance and food safety system for agricultural products. Furthermore, it guarantees and protects consumers, facilitates the retrieval of possible deviations in product quality and safety or traceability, and increases the value-added and competitiveness in the market. The findings also highlighted the need for government support to provide a CE model so that actors have an example to refer to when implementing CE.

Table 21 Barriers to CE adoption

Barriers	Category	Case																			
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**
Lack of knowledge of CE	Knowledge	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Perfect product specifications	Structural	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Land contour		X	X	X	X	X	X	X	X	X	X										
Remote locations		X	X	X	X	X	X	X	X	X	X	X	X								
Business risks																	X	X	X	X	X
High investment for advancing technology	Financial	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
High cost for upgrading packaging		X									X					X	X	X	X	X	X
Poor practise land filling	Lack awareness of environment																X	X	X	X	X
Burnt waste			X	X		X	X	X	X	X											
Volatile price	Supply chain	X	X	X	X	X	X	X	X	X	X										
Over supply		X	X	X	X	X	X	X	X	X	X										
Lack of support from other chains		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Group dynamics			X	X	X	X	X	X	X	X	X										
Long supply chain in other channels		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Unavailable sustainable packaging on a large scale																X	X	X	X	X	X
Uncertainty in supply of seeds		X	X	X	X	X	X	X	X	X	X										
Low improvement in farming technology on a commercial scale	Technology	X	X	X	X	X	X	X	X	X	X										
Technical problems with sustainable packaging		X										X				X					
Reluctance to change	Culture		X	X	X	X	X	X	X	X											
No model for CE	Lack of government support	X	X	X	X	X	X	X	X	X	X										
Unclear regulation			X		X	X	X	X	X	X	X										

6.3 Natural resource-based view, Circular Economy principles and outcomes

Consistent with the theory-elaborating case study design, this thesis employs a combined retroductive-abductive research strategy. Retroductive research focuses on the underlying mechanisms of a phenomenon, whereas abductive research requires the researcher to switch back and forth between developed theory and empirical data (Ketokivi and Choi, 2014) in order to generate plausible explanations for a phenomenon (Ketokivi, 2006). This process ensures that the process of unravelling the underlying mechanisms of the CE phenomenon in the agri-food supply chain is guided in this thesis by NRBV as a theoretical perspective. The nature of this thesis adopted critical realism with the abductive theory elaborating for theory advancement in developing new theoretical insights (Fisher and Aguinis, 2017). This section explained the relationship between each strategic capability of NRBV, particularly the link to its resources with the CE principles and outcomes, which were postulated in the initial framework. The within-case and cross-case analyses alongside the initial framework have resulted in the refinement of the framework. A wide range of organisational capabilities has been identified to reveal the capabilities that exist in each resource of NRBV in the context of agri-food supply chains. The stratified ontology in the critical realism of the "real level domain" explains the mechanism of the role of resources in NRBV as the antecedents of CE principles described by several propositions. Table 22 shows the general pattern of operational capabilities exhibited in the supply chains up to the level of actions. Whereas the initial and refined propositions against cases can be found in Appendix C.

The development of the propositions started with the strategic capabilities of NRBV and the relationship with CE, followed by a set of propositions that can be classified into three main sections based on the strategic capabilities of NRBV; the first one is pollution prevention, followed by products stewardship and sustainable development. In this regard, the outcome and propositions related to barriers are also explained. The first proposition covers the general agreement of the agri-food supply chains in NRBV, particularly of its resource having a significant role as the antecedents of CE principles. Although it is supported based on the common ground in the level of actions, based on the data, the relationship between the resources of the NRBV and CE principles is exhibited in the operational capabilities across the supply chain, which serves sufficient to justify the propositions. These differences in actions are indicated by the fact that the different positions of supply chains bring consequences for diverse actions. Thus, leading to the following propositions:

Proposition 1a: In the context of the agri-food supply chain, the strategic capabilities of the NRBV serve as the antecedents of CE principles.

Pollution prevention cannot be implemented in isolation from product stewardship. It is discovered that a process exists in which events in pollution prevention inform product stewardship and vice versa as input for incremental improvement in the pollution prevention strategy. Pollution prevention benefits from product stewardship that is intrinsically socially complex and contributes to accumulated experience for better internal process. This thesis argues that both pollution prevention and product stewardship are interdependent. With effective implementation of these two strategic capabilities, the CE principle will be acquired and importantly, when coupled with a progression of the relationship from transactional to more symbiotic, as this is the root of the CE. The regenerative system is built collaboratively within the business by consciously integrating an environmental approach into the business on both an internal and external level.

Proposition 1b: In the context of the agri-food supply chain, the strategic capability of pollution prevention is interdependent with product stewardship allowing them to be implemented together, thereby facilitating the adoption of CE principles.

Moving on to the formulation of propositions that relate to the resource of strategic capability of NRBV, beginning with pollution prevention, a key resource is continuous improvement. The findings showed that almost all cases exhibited proactive waste prevention. Pollution prevention encompasses the activities required in preventing pollutants, waste and emissions before they are created, starting with the upstream cultivation, harvesting, and post-harvest management processes, ending with downstream product delivery. It is evident that continuous improvement is a priority for most firms and affirmed as the main resource for waste prevention. The capability was discovered to be ingrained in their lean management practices and effective planning strategy. These include reducing waste on farms and in warehouses, as well as proper handling. Therefore, proposition 2a is supported by all Cases A to T, suggesting the relationship is strong:

Proposition 2a: In the context of agri-food supply chains, firms that have continuous improvement will effectively adopt waste elimination endeavours.

All actors are aware that they are involved in perishable products susceptible to deterioration. Moreover, most plants are not native and therefore must be planted in the highlands to imitate their natural habitat as closely as possible, the different temperatures contribute to damaging the products quickly and decreases the value. Therefore, an effective logistics system is essential. This includes streamlining the process, shortening harvest and delivery times, having appropriate delivery schedules, and maintaining a cold chain to preserve the value of the products.

Proposition 2b: In the context of agri-food supply chains, firms that have a resource of continuous improvement will preserve the value of their products.

According to the data, agri-food supply chains that are continuously improving can optimise the economy by having accurate forecasting that is demand-driven rather than supply-driven, ensuring that what is produced or ordered is marketable**.** Intensive supervised cultivation across the upstream and midstream also help ensure products are looked after correctly in order to produce only the highest quality products. Furthermore, understanding product knowledge is crucial in economic optimisation as it allows firms to understand the market demands regarding the product specifications needed, and to then plan how products are produced, displayed, handled, stored, and sold as effectively as possible to preserve their shelf life whilst accommodating customer demands.

Proposition 2c: In the context of agri-food supply chains, firms that have a resource of continuous improvement enhance economic optimisation.

The data demonstrate that there are actors with extensive collaboration with various stakeholders capable of developing the necessary capabilities and improving existing capabilities to obtain incremental gains through collaboration with other stakeholders. For instance, Case B have been in cooperation with international NGOs, from which they received a transfer of knowledge on good cultivation techniques, marketing, and development of variant products, which they apply to this day. They also improve their quality assurance by seeking government certification as evidence of recognition that the agricultural produce has fulfilled the requirements in the safe consumption category. Similarly, Case D also benefits from collaboration with international NGOs in improving their operations, as the organisations assisted Case D in gradually transforming to address environmental issues and help them to develop an extensive portfolio of product variants.

Proposition 3a: In the context of agri-food supply chains, firms that have the resource stakeholder integration and successfully leverage extensive collaboration of stakeholders inform the identification of improvement the existence of capability and build necessary capability needed, reinforcing continuous improvement.

Table 22 General pattern of actions, operational capabilities, NRBV and CE principles across the supply chain

NRBV (Strategic capability)	Resource	Operational capabilities	Actions	CE Principles	Case																			
					A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Pollution prevention	Continuous improvement	Planning	Forecasting supply and demand	Waste Elimination Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Delivery scheduling	Maximisation of retained value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Operational Process	Lean process	Waste elimination Maximisation Retained Value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Proper handling	Waste elimination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Control	Waste prevention		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Intensive supervision of cultivation	Waste Elimination Economic Optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
		Learning Process	Understanding product knowledge		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Learning from stakeholders		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Accumulated experience		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Training for proper handling	Waste elimination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Culture	Strong commitment to reduce waste	Waste Elimination Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Product stewardship	Stakeholder integration	Information sharing	Demand data sharing	Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Intense communication with customers and suppliers for product development and new variants		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			Communicating with suppliers		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		High order learning	Learning from other networks and associations		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Food safety compliance	Certification (GAP, Prima, Organic, ISO, Halal, and HACCP), auditing internal and external	Leakage Minimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Using sustainable material	Reusable crates	Environmental consciousness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Food waste mitigation	Distribute below specification product to other channels	Waste Elimination Cascades Orientation Economic optimisation Maximisation Retained Value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
			Processing food for value added products/derivative products		X		X		X								X			X	X	X	X	X
			Re-package		X									X						X	X	X	X	X
			Promotion																	X	X	X	X	X
Sustainable development	Shared vision	Digital technology	Digital technology adoption websites, apps, and social media	Waste Elimination Economic optimisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Social cohesion	Corporate social responsibility (earth hour, charities, reforestation, global green hospital, agrotourism, food donation)	Social Responsibility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Essentially, all actors are aware of the imperative to optimise the economic benefits by maintaining high-value products, which means that all actors share the same orientation towards cascades. However, it is more flexible in the upstream as they have an extensive approach compared to midstream and downstream. In the upstream, the cascade actions comprise of redistribution to other channels, such as traditional markets, hospitality industry, and food processing industry, up to utilisation with no economic value being composted. However, the downstream faces strict procedures of food recovery and are more cautious because they are bound to a commitment to protect their reputation and brand, such as limited recovery of food for derivative products. Even though they have different cascade methods, they shared a common practice of cascades orientation. Hence, this could conceivably arrive at the following proposition:

Proposition 3b: In the context of agri-food supply chains, firms that have the resource of stakeholder integration enable an opportunity to optimise cascades' endeavours and will be able to optimise economics.

Environmental consciousness is shown across all firms, as they use reusable crates to transport their produce; this is also seen in a few cases as they also use more environmentally friendly cardboard boxes. Despite the lack of any replacements for plastics and styrofoam that are more affordable and accessible, it was found that firms are aware of the need to use more sustainable packaging and that some were even able to utilise recyclable plastic packaging. In addition, an increase of awareness towards using food waste to be composted and/or as for food for animals was seen in the upstream and midstream, where firms have also started to collaborate with state-owned companies for proper waste management.

Proposition 3c: In the context of agri-food supply chains, firms that have the resource stakeholder integration enable the establishment of environmental consciousness.

In the food system, food safety compliance is important. Measures are taking place in the form of certification of food safety from local government across supply chains. The common practice in relation to the best procedures for upstream is the application of GAP, organic certification, and local government certification. Referring to the FAO, GAP is the guidance given to assist growers, and comprises food safety, quality, environmental management and workers' health, safety and welfare, whereas the midstream faces packing house certifications. Along with certification, midstream have an internal division that monitors food safety, such as Case O that conducts routine laboratory tests for pesticide residues and E. coli as part of their commitment to responsible sourcing. Meanwhile at the downstream, their certifications include ISO, Halal, HACCP and a hygiene team that oversees food safety;

additionally, there are government supervisors who monitor food safety on a regular basis. This thesis has identified another waste stream that has a detrimental effect on the environment: the use of styrofoam and conventional plastics are still widely used by all the agri-food supply chain. However, cases are beginning to recognise their problem and are transitioning to more environmentally friendly alternatives.

Proposition 3d: In the context of agri-food supply chains, stakeholder integration facilitates leakage minimisation.

One unexpected finding was the emergence of digital technology adoption in the domain of sustainable development strategies. Investing in tomorrow's technology is not always in the form of advanced technology that requires substantial investment. It is evident that the majority of cases adopt digital technology. Although its application is limited to coordination and sharing information, digital technology enables information flow efficiently and enhances economic optimisation. Digital communication helps decision making promptly and thereby contributes to waste elimination. Additionally, the advancement of social media has positively impacted supply chains, allowing them to observe the trends and assist them in learning. Similarly, digital technology has started to be extensively used for developing web system applications, such as for wireless irrigation. Applying irrigation remotely can save water use, reduce human error and provide precision irrigation, thus contributing to preserving natural resources. Digital technology application is also used to develop online markets that were previously underdeveloped due to consumers being accustomed to purchasing products in person from shops where the products are physically visible. But now, online shopping has begun to appear as supply chains recognise the opportunities from a market gap that can be exploited as a new distribution channel.

Proposition 4a: In the context of agri-food supply chains, firms that have the resource of shared vision through digital technology adoption enable information flow that contributes to economic optimisation.

The data found that all cases undertake social activities, demonstrated by community involvement in the business and social collaboration to address environmental issues, seen as to how the upstream and midstream collaborate in mutual benefits by establishing partnerships. Growers optimise their economy by expanding into new market and have the ability to market products in various distribution channels. They also provide promising agricultural work for locals, thereby contributing to community welfare. These growers also organise agro-tourism and reforestation to combat erosion. Whereas in the downstream, partnerships with charities can significantly reduce energy consumption. Installing solar photovoltaic panels as energy for lighting has also supported the concept of being environmentally friendly.

Proposition 4b: In the context of agri-food supply chains, firms that have the resource of shared vision adhere to social cohesion, supporting social responsibility.

The thesis cannot fully reveal the relationship between CE principles and outcomes. This can be explained by the adoption of CE still being low, despite the emergence of CE principles. In the refined framework, the relationship between CE principles is depicted with a dashed line, indicating that there is a relationship but are not fully supported by all cases. There are four outcomes of CE principles that have been identified. The first outcome of waste elimination is reducing FLW, supported by all cases A to T. The second outcome that can be revealed is the principle of leakage minimisation prominent in the upstream that has the outcome of preserving natural resources. Leakage minimisation appears on how the upstream have implemented soil management by treating soil using natural nutrients, and applying integrated pest management to the use of drip irrigation, all of which is claimed to protect natural resources of soil from hazardous substances and save water use. Additionally, upstream initiatives to compost food waste are a form of leakage minimisation, enabling food waste to be used as soil nutrients.

Some cases support the outcome of the CE principle of social responsibility. One of the outcomes of implementing social responsibility is reducing greenhouse gases, by supporting the global green and healthy hospitals' global movement to tackle climate change and promote public environmental health; however, this is only supported by Cases F and I. Another outcome is improving the local economy, supported by cases upstream and midstream on community involvement in the business. Among the several efforts made throughout the supply chain, significant actions correspond to the efforts aimed at the CE principle of economic optimisation, which should result in a resilient economy; yet the outcomes remain obscured.

Moreover, lack of knowledge about CE factors influence why firms cannot decide on suitably high investments that could help their type of firm. Structural aspects such as land contour, remote locations and perfect product specifications also serve as the main barriers to CE adoption, particularly in the upstream where seemingly more efficient technologies become a hindrance instead, so human labour is heavily relied upon. However, in the downstream, business risks are taken into great consideration, as changes and adaptations made could jeopardise profit generated and not accommodate customer demands. Similarly, high investment in advancing technologies is presented as a barrier across all types of firms, further suggesting that these technologies provide more issues and risks than benefits to the firm. This also applies to upgrades in packaging, particularly in the downstream, as more sustainable packaging is often unavailable and not economically viable.

Proposition 5: In the context of agri-food supply chains, the main barriers to CE adoption are lack of knowledge, structural and financial, that hinders the transformation towards CE practices.

Figure 42 shows the refined framework of Circular Capability. The solid line shows the relationship is supported across cases, while the dashed line is partially supported by some cases.

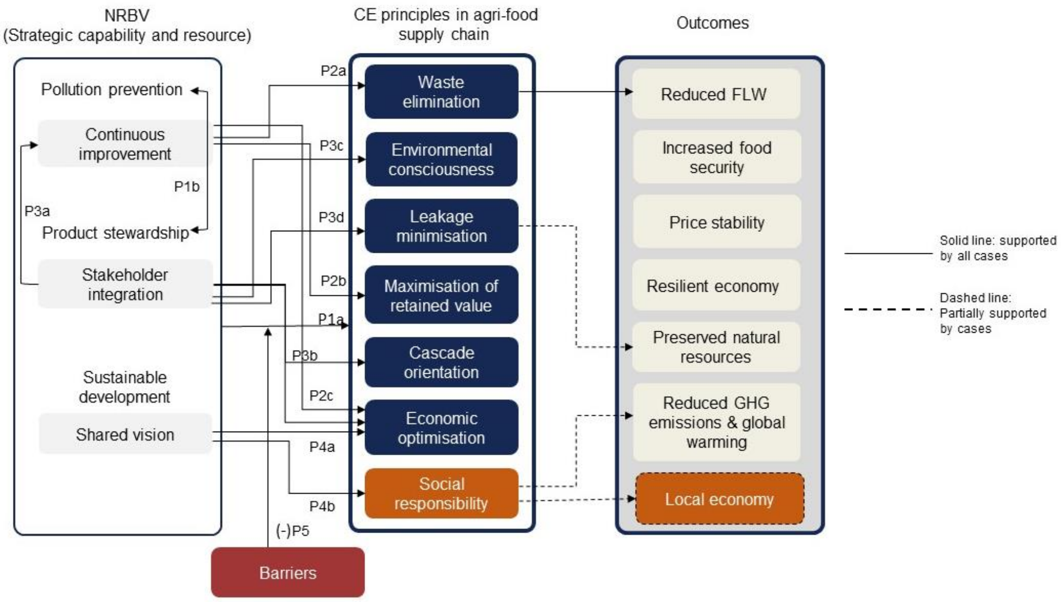

Figure 42 The refined framework - Circular Capability Framework

6.4 Summary cross-case analysis

This chapter presents the cross-case analysis of the twenty cases to examine their similarities and differences, which ultimately help answer the research question and achieve the objectives. Starting from identifying actions and classifying to the levels of operational capability, the thesis found a general pattern that occurs at each stage of the supply chain up to the actions level. The higher level entails the identification of the operational capabilities in the resources of a strategic NRBV, in which these resources served as antecedents of CE principles. The antecedents act as a stimulus that prompts actors in the agri-food supply chain to engage, reinforcing the consequences of the principles of the CE. Different enactments of the principles emerged as cases have different functions in the supply chains, resulting in divergent capability deployment. In order to maintain an open mind to unanticipated findings that Ketokivi and Choi (2014) believe to lead to the reformulation of general theory, the thesis supports the importance of the critical role of serendipity in theory elaborating case studies. This thesis found unanticipated findings from the data set, particularly in the construct of the strategic capability of sustainable development. First, is the use of advanced technology aimed at reducing environmental impacts, that are not fully supported by the agri-food supply chain context due to the slow development of technology in approaches of economies of scale. Market structure issues also make actors hesitate to invest in that direction. Furthermore, there is disparity of environmental awareness across supply chains.

Moreover, social responsibility will be integrated with other CE principles, aligning with the social aspect as part of sustainable development. The key resource of sustainable development is shared value; initially defined as the avenue to alleviate poor society by creating new market segments that are considered affordable, thereby firms could gain the advantage of growth from the new target market. However, looking at the commodities produced by the actors of the supply chain, they focus on producing high specifications to gain economic advantage because other secondary market segments are not as reliable, and pose economic risks due to the long supply chain - considering the perishable characteristics of product - instead, they expand to the export market with higher value.

The same applies to modern retailers who argue that they need to differentiate between traditional markets and seem to doubt that they can gain growth by developing lower market segments. The social responsibility principle is manifested as the inclusiveness of the community into the business, i.e., community empowerment. Social orientation also appeared when both the upstream and midstream assisted one another in selling the products and supports social movement for the environment. Hence, the outcome of the CE principle of social responsibility is improving the local economy. The propositions were explained along with the supporting cases. This thesis partially supports Hart’s (1995) conceptualisation that pollution prevention and product stewardship are interconnected, but argues that it is not necessarily path dependence, as originally postulated. Having the results of the thesis, it can be concluded that although the principles of CE were exhibited by most of the actors, any behaviour that reflects leakage minimisation principles in the downstream was not found. The process of breakage and poor practice landfilling due to the inability of the downstream to connect potential waste back to supply chains, result in lost materials that could have been used for other purposes. Finally, the cross-case analysis results in the refined Circular Capability Framework deemed relevant to context of agri-food supply chains.

CHAPTER 7 DISCUSSION

The previous chapter explored the findings to answer the research question and address the research objectives. This chapter mainly discusses how the study addressed the research question, objectives and gaps in relation to the existing literature, by focusing on the use of a theoretical lens (NRBV) and a framework for CE adoption, which enabled the study to make original contributions to knowledge. The chapter begins with an explanation on the use of NRBV as a theoretical lens. Likewise, in order to evaluate the answers to the research question, the chapter discusses the use of the CE framework to address the research question in comparison to the extant literature. This thesis found NRBV to be the antecedent of CE principles, which is the novelty offered by this research. This is followed by a discussion of the limitations in applying the findings of this study to the broader context of CE adoption, specifically, the use of the Circular Capability Framework. The chapter concludes with contributions to knowledge and practice.

7.1 Advancing NRBV as a theoretical lens in Circular Economy research

Reflecting on how the thesis will address the research question and research objectives, this thesis determined that NRBV is an appropriate theoretical lens to study CE as the NRBV theory displays features resembling the CE (see Chapter 2), i.e., it follows the concept of a life cycle approach, and offers competitive advantage by way of cost leadership and differentiation. Using case research with the aim of theory elaborating enabled the theory advancement of NRBV in answering the research question on “How do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?”. This relates back to Fisher and Aguinis (2017) who defined theory elaboration as “the process of conceptualising and executing empirical research using pre-existing conceptual ideas or a preliminary model as a basis for developing new theoretical insights by contrasting, specifying, or structuring theoretical constructs and relations to account for and explain empirical observations” (2017: 441).

This thesis utilises case research for theory elaboration that falls into the category of structuring theoretical constructs, by defining a specific relationship between two constructs with the purpose of improving explanatory and predictive adequacy. The two constructs in this case are the relationship between NRBV and the CE principles, which are yet underlined properly. This thesis identifies that all the resources of strategic capabilities in the NRBV acts as antecedents of CE principles. The relationship between NRBV and CE adoption is depicted through the initial framework along with the propositions, which are the results of the systematic literature review described in Chapter 3. The initial framework has been refined after the data analysis and resulted in adjusted propositions, which are explained in Chapter 6. Moreover, by conducting a review of the academic literature on CE and its practical implementation in general, gaps in the literature indicate a lack of focus on CE research employing a theoretical lens; this reinforces Dora et al. (2021) who argue that the prevention of FLW through the lens of the CE is a reasonably new concept, therefore new theories are required to comprehend the bridge between CE principles and its implementation. Additionally, it was determined that the existing literature on CE concentrated on practical waste management recommendations that is, according to the NRBV, the “end-of-pipe” that has costly consequences compared to waste prevention (Hart 1995).Therefore, this thesis argues that prevention should take priority over cleaning up waste as it aligns with pollution prevention, where waste generated by the product is reduced or prevented (Graham 2018). Thereby waste prevention facilitates lower costs and enhances the cash flow and profitability of firms (Hart 1995). However, there is currently no framework available for the adoption of CE, in particular in the biological domain (see the butterfly diagram, EMF (2013a), in Chapter 1). Thus, this thesis extends the use of the NRBV perspective using the phenomenon of CE to help in bridging these gaps.

It is evident that despite extensive research on CE, utilisation of theoretical lenses is still limited to some extent. Some research that does, however, includes utilising the resource dependence theory to elucidate barriers to the implementation of CE (Farooque, Zhang, and Liu 2019) as it is perceived that organisations are interdependent. Hence, barriers could arise when supply chain actors are not willing to collaborate and support the implementation of CE. Jabbour et al. (2019) used other theoretical lens such as resource-based view (RBV) and dynamic capabilities (Jabbour et al. 2019) as their paper sought to identify the operational changes needed for the CE business model. Transaction cost of economic can be utilised with the aim to analyse the transactions and governance structures linking value chains in CE for reusing wastewater and sewage sludge in agriculture (Maaß and Grundmann 2018), to clarify the role of transactions in the diffusion of CE practices (Dossa et al. 2020). Additionally, institutional theory is used to study the causes of isomorphism; factors leading organisations to adopt similar structures, strategies and processes (Dubey et al. 2019). Therefore, the theoretical lens that can be utilised relates back to the purpose of each respective research, where NRBV was considered appropriate for observing the CE phenomenon as the answer to the research question of this thesis, and associated with exploitation of natural resource and waste prevention.

A considerable amount of research employed NRBV as a theoretical lens in studies related to environmental practices (Menguc and Ozanne 2005, McDougall, Wagner, and MacBryde

2019, Mena et al. 2014, Rodrigues et al. 2021). NRBV is also used as a theoretical lens related to the study of green supply chain management (Nishant, Goh, and Kitchen 2016) and closed loop supply chains (Ashby 2018), the latter being closely related to CE; some even argue that closed loop is used interchangeably with CE (Hussain and Malik 2020) as it recovers waste through the processes of refurbishing and recycling. Sarkis, Zhu, and Lai (2011) outlined nine influential organisational theories, two of which are directly related to resources. These are resource dependent theory (RDT) and the resource-based view (RBV), which are specifically related to study waste and resources; the most relevant organisational theory used is NRBV, which is a spin-off of RBV as also argued by Mena et al. (2014). This reinforces the argument of this thesis for utilising NRBV as the theoretical lens when studying the CE phenomenon related to FLW and supports the statement that there is a relationship between NRBV and CE (Mishra, Chiwenga, and Ali 2019).

The novelty of the thesis is that all the resources of strategic capability in NRBV enable CE principles as antecedents that have not been discussed in the literature, especially in agri-food supply chain studies related to FLW. It is identified that there are existing literatures presenting strategic capability pollution prevention as the antecedent facilitating the progression to product stewardship and using another theoretical lens, dynamic capability, as a mediator between pollution prevention and product stewardship (Graham 2018, Miemczyk, Howard, and Johnsen 2016). Hart (1995) stated that pollution prevention, product stewardship, and sustainable development are interconnected, and for this reason a mediator between one strategy and another is not required, as described in the framework by Ashby (2018) in developing closed loop supply chains. Nevertheless, this thesis found that there are only two strategic capabilities that are closely related: pollution prevention and product stewardship. Unlike other literature which argues that NRBV should be combined with dynamic capabilities (de Almeida et al. 2021, Graham 2018), this thesis believes that no additional theory is required to elucidate the capability within NRBV, considering that NRBV is a proactive environmental strategy; therefore, additional empirical research is required to understand what capabilities are needed to implement the strategy effectively as this thesis attempts to fill the gap.

A careful examination of the literature that employs NRBV discloses the fact that the capabilities described in the literature are diverse and are predominantly used to measure environmental performance or sustainable performance (Caldera, Desha, and Dawes 2018, Graham 2018, Nishant, Goh, and Kitchen 2016). Although Hart (1995) identified the key resources of each strategic capability, the role of each capability remains unclear and not mutually exclusive (Rodrigues et al. 2021); therefore, this thesis fills the gap by revealing the appropriate capability for each respective resource as well as the capabilities at the operational level across supply chains, specifically in the agri-food context in tackling FLW.

Whilst the majority of the literature that utilises NRBV does not always conduct studies using the three strategic capabilities, this thesis uses them as an overarching framework to explore and reveal the capabilities of each key resource and demonstrate their interconnectedness, as suggested by Hart (1995). This thesis reveals the operational capabilities of each resource and classifies the actions undertaken that are found in each case. Continuous improvement, a key resource of pollution prevention, comprises capabilities related to planning, operational process, control, learning process and culture. This is done through classification of activities attempted by firms on how they established continuous improvements within their internal operations and how the implementation process is affected and positively influenced by the learning process at the supply chain level, as described in Chapter 4. Figure 43 shows strategic capabilities in NRBV, resources with operational capabilities that represent CE principles related in FLW in the agri-food supply chains.

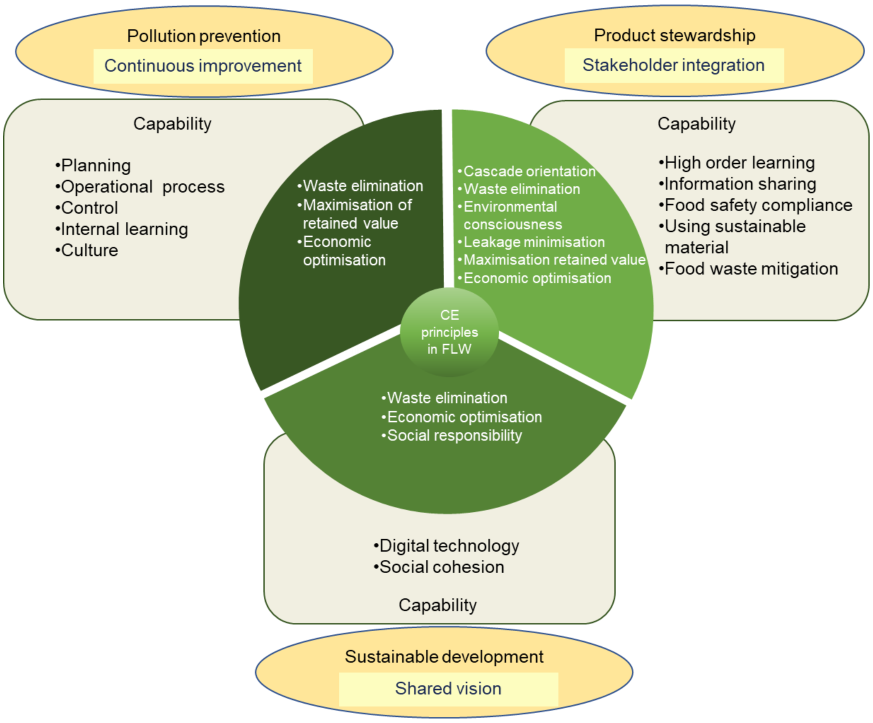

Figure 43 Strategic capabilities, resources, operational capability correspond to relevant CE principles

A wide array of actions is exhibited across supply chains as consequences of the different positions in the supply chain. Actions in the planning capability include forecasting supply and demand, and delivery scheduling. Operational processes, on the other hand, involve lean processes and proper handling. Whereas capabilities related to control demonstrates waste prevention. Moreover, actions included in the learning process capability entails understanding product knowledge, learning from stakeholders, accumulated experience and training for proper handling. Additionally, cultural practices also demonstrate a strong commitment to reduce waste.

Whilst this thesis found that pollution prevention showed some activities occurring at all stages of the supply chain such as planning and forecasting, and streamlining internal process to prevent waste, a recent study by McDougall, Wagner, and MacBryde (2019), who conducted research on the UK food industry seeking to find NRBV in practice, stated that pollution prevention is manifested in prevention related to cardboard waste, plastics, water pollution, soil pollution, carbon and emissions associated with machinery, pesticides, and fertiliser. Hence, the prevention focus remains consistent in the internal system and processes.

Product stewardship includes key resource stakeholder integration where responsibility is shared in maintaining the product from the start of production stage until the end of its life throughout the supply chain level. This includes the creation of products designed to be more environmentally friendly, thus making for a more easily compostable, reusable, or recyclable product resulting in a low life cycle cost (Hart 1995). In this thesis, operational capabilities are found and categorised into information sharing, higher order learning, food safety compliance, using sustainable material, and food waste mitigation. Information sharing capability includes actions such as demand data sharing, communication with suppliers and retailers, and intense communication with customers and supplier for product development. Higher order learning capability is learning from other networks and associations. Food safety compliance capability amount to actions obtaining certifications (GAP, Prima, organic, ISO, halal), and conducting internal and external audits. Meanwhile, there is also the use of sustainable material, i.e., in the form of using reusable crates. Food waste mitigation capability includes actions to distribute below specification products through other channels, processing food for value added products or derivative products, re-packaging, and promotion.

The manifestations of product stewardship are demonstrated by activities engaged in level supply chains such as establishing relationships between growers, distributors and retailers, and sharing information, which is in line with McDougall, Wagner, and MacBryde' (2019) study, which states that the success of product stewardship is not the outcome of a single firm but rather requires the collaboration of many stakeholders. However, in terms of collaboration at the supply chain level, it was found that firms have yet to progress towards concerns about environmental impact as their motives are generally economically driven. The finding differs from other literature where environmental awareness has been integrated in the firms, thus affecting firms' implementation of environmental strategies (Galeazzo, Furlan, and Vinelli

2014, Graham 2018) and addressed as 'genuinely sustainable' across supply chains as a manifestation of product stewardship's lifecycle focus (McDougall, Wagner, and MacBryde 2019).

The empirical finding showed a difference with Caldera, Desha, and Dawes (2018), who argues that another strategic capability needs to be added to the NRBV, namely regenerative development that has a practice similar to CE to enhance ecosystem health and build resilience. However, this thesis argues implementing pollution prevention effectively will reduce resource inputs and, together with product stewardship, allow products to be retained and waste to be processed in such a way that it can be returned safely to the biosphere. Despite this disagreement with Caldera, Desha, and Dawes' (2018) paper, their findings still strengthen the thesis argument that NRBV has a relationship with CE, where in fact NRBV serves as the base of CE. Meanwhile, for the shared vision resource, the findings showed that there are activities to utilise technology and agricultural innovations such as energy technology, water technology, and agricultural technology, resulting in innovative irrigation systems and digitising agricultural practices. Digitising agricultural system activities include websites, apps, and social media. There are also various social activities such as involvement of the business community, grower's welfare, food donations to employee and the community, and CSR (Earth Hour, charities, reforestation, global green hospital and agro tourism) all of which have similarities to clean technology and local philanthropic activities. This finding is in line with McDougall, Wagner, and MacBryde (2019) who argue that BoP does not occur in the context of UK agri-food supply chains. Instead, they conceptualise the local philanthropy that emerged from their research and propose it as an additional resource of NRBV. Sustainable development has key resources of shared value consisting of operational capabilities related to technology adoption, food processing, waste processing, future orientation to advanced technology, digital technology adoption, and social cohesion. Similarly, McDougall, Wagner and MacBryde (2019) explained that the activities needed for realising clean technology are in the form of developing energy technology, water technology, transportation technology and material technology, as well as creating efficient and innovative agricultural processes.

Sustainable development and its resource of shared vision involves technology innovation that impacts less on the environment and encompasses firms' economic and social concerns (Hart, Milstein, and Caggiano 2003). Although most actors agree that technology offer significant advantages, technology innovation is not always seen as an important aspect that makes actors willing to apply a disruptive change by investing (Cristina De Stefano, Montes-Sancho, and Busch 2016). Some technology adoptions are found to be limited in numbers; these include the use of greenhouse drip irrigation systems, cold storage and showcase chillers which serve to minimise the occurrence of waste and prolong the life of the products. The main factor seen as a consensus by all the actors within the supply chain is that a high investment is needed, but technology available in this industry is limited. This is indicated by cases B, H and L, where the development of technology is found to be slow and requires substantial investment that in turn will be measured by the return on that investment. Case L exemplified their future orientation of technology adoption with greenhouses for their partner growers.

Scharfy, Boccali, and Stucki (2017) explained that technology in agriculture becomes clean technology when it meets economic, ecological and social criteria, such as economic aspects regarding how much fossil energy can be saved, investment cost, and life cycle cost. With the ecological aspects involving saving water, biodiversity and soil quality, and the social criteria concerns how technology is accepted in terms of landscape compatibility, its applicability and its function to alleviate human work. In reference to the aforementioned study, some of the technology used by the growers meets the ecology criteria; cases A, C, and I use drip irrigation systems that aims to save water, and case O uses a wastewater treatment before disposal, which is part of their responsibility to the environment.

Considering that market price of commodities is volatile, making substantial investments will depend on the market conditions. The use of advanced technology also means changing technology to be more environmentally friendly and ensuring that excessive use of machines or any technology does not harm the environment (Hart, Milstein, and Caggiano 2003). This idea, however, is not fully grasped by most actors because agricultural products are not considered polluters compared to manufactured goods. Additionally, the development of the available technology is considered to be slow. However, actors agreed that investment in advanced technology is possible with positive external factors such as a promising market demand and stable market prices.

In relation to technology adoption, one emerging response is the use of digital technology that is considered unanticipated findings in this thesis. Digital technology adoption is seen to have a tremendous impact in helping all the actors in their routine operations, such as information sharing for procurement systems. They also use digital technology as a means for the learning process to update their knowledge, contribute to better processes, and update trends through social media and communication within their network. According to Rodrigues et al.(2021), digital technology is part of technology advancements in which going online is considered part of clean technology; as online systems enable information sharing, food waste can be mitigated more effectively.

The implications of findings in the extant literature are the sequence of the NRBV. Hart (1995) conceptualised that the environmental strategies are path dependence and overlapping, meaning that pollution prevention is the first strategy for the firms before the next strategy of product stewardship can be achieved (see Figure 6). This thesis supports only part of the theory that was originally suggested by Hart (1995), that NRBV is not just interconnected but also interdependent between strategies, pollution prevention and product stewardship, despite not being sequential. These results corroborate those of Ashby (2018) who challenged the path dependent nature of NRBV in a recent study of the closed loop supply chain, where pollution prevention becomes the starting point for environmental sustainability and is not necessarily path dependence with product stewardship.

This thesis argues that pollution prevention needs to be implemented together with product stewardship as they are interdependent. The key resource of continuous improvement will benefit from the exploitation of stakeholder integration to allow better accumulated experience that ultimately means better internal processes within firms. The thesis discovered that actors within the supply chain strive to prevent waste and pollution, despite being driven by economic aspects. This also shows that accumulated experience plays an essential role in determining the planning and execution processes. The findings reinforce that pollution prevention is tacit knowledge that is skill-based and people-intensive (Ashby 2018, Hart 1995). Culture was also found to influence continuous improvement which provided direction for companies to produce quality products and prevent waste.

Particularly for upstream, who need time to produce and are dependent on other suppliers, obtaining information is crucial. The most common approach taken by actors in the supply chain is to study historical sales. However, the uncommon practice of contract establishment can protect both upstream and midstream from the interests of downstream, who sometimes reject the products for insufficient reasons or because stock is still available, causing losses for other actors. Therefore, having fluid communication is beneficial to reduce the risk of waste (Rodrigues et al. 2021). As outlined previously, pollution prevention is tacit knowledge, and product stewardship is socially complex, meaning that it is built from many actors that are involved in the supply chain. Specifically, groups of growers that have extensive stakeholder collaboration benefit from transfer of knowledge. Mishra, Chiwenga, and Ali (2019) argue that NRBV collaboration is an enabler of CE, as building resources cannot be done in isolation but by establishing collaboration. While close collaboration is evident in this research case, it has yet to result in the development of the full creation of an environmentally friendly product design. This can be explained by a general lack of environmental awareness across all supply chains. Additionally, product development is still limited to the measurement of costs and benefits.

Likewise, Aboelmaged (2018b) conveyed that SMEs experience limitations in technical capacity, financial limitations, and limited human resources, despite stating that the lack of members and an informal work culture are able to facilitate the transfer of information by managers. This thesis identified a high involvement of the community in the business. Based on the findings, small companies should increase their involvement in the business community so that a close relationship can be built to assist one another and exchange information. In line with that, to deal with the obstacles faced by SMEs, Mishra, Chiwenga, and Ali (2019) emphasise the importance of collaborating to build the involvement of stakeholders which will streamline resources and facilitate the application of technology, to achieve a CE-based business model. Caldera, Desha, and Dawes (2018) revealed that SMEs that run a sustainable business model will have characteristics such as environmentally-based company management and optimising and streamlining processes, therefore continue to provide education and create awareness, where this has been exhibited by all the firms across supply chains, suggesting their shift towards more sustainable practices.

7.2 Conceptualising Circular Capability Framework as the mechanism of CE adoption

This section explains the circular capability framework covering the researcher's attempts to establish plausible theoretical interpretations of the findings and discuss them in relation to the relevant literature. This thesis produces a conceptualisation of a framework for adopting CE principles in overcoming FLW. The findings have implications for the initial framework and resulted in a refined framework and propositions. The refined framework derived from cross-case analysis with propositions generated from literature which differ from the findings, found that not all propositions are verified as they are not supported by all cases (see Figure 44). Thus, the following paragraphs are divided into three sections: explaining antecedents, CE principles, and outcome and barriers compared to the extant literature.

7.2.1 The NRBV as the antecedents of CE principles

As in the literature, NRBV has been positioned as the antecedent enabling closed loop supply chains in the domain of the manufacturing industry (Ashby 2018, Miemczyk, Howard, and Johnsen 2016); however, there is no framework found in the literature that draws a relationship between NRBV to and the CE principles and the outcomes. Therefore, this thesis conceptualises arguments and explains NRBV as the key antecedent of CE principles, in the extension of practices to the CE. This overarching framework draws links between NRBV resources and CE principles, with the role of CE principles as a mediator of CE outcomes. where the latter case suggets that reducing FLW is the most important outcome. This refers to Bacharach (1989), who explained the organisational theories as components of various levels of abstraction, variables and constructs, and the relationships that connect them. Construct may be viewed as a broad mental configuration of a given phenomenon, while a variable may be viewed as an operational configuration derived from a construct. Antecedents refers to the element factor that triggers an effect or a necessary condition for the consequence; accordingly, in this framework, NRBV is considered as an antecedent to trigger CE principles. In this work, CE principles act as interventions to achieve the main consequences of food loss and ensure waste reduction.

Based on these findings, Proposition P1a is built to show the relationship between NRBV as an antecedent for CE principles. NRBV supports the establishment of the CE principles in which each strategic capability has resources related to one or more CE principles. The literature shows the strategic capability of NRBV as an antecedent. A study by Mishra and Yadav (2021) shows that strategic proactivity, shared vision and continuous improvement capabilities, as strategic capabilities of the NRBV, support a proactive environmental strategy that has an impact on competitive advantage. As no existing literature has yet to posit NRBV as an antecedent to the CE principles, this thesis provides a novelty that enriches knowledge both on NRBV theory and in explaining the CE phenomenon. In addition, the strategic relationship between pollution prevention capability and stakeholder integration raises Proposition P1b.

The strategic capability of pollution prevention is not only interconnected but also interdependent with product stewardship, allowing them to be implemented together, thereby facilitating the adoption of CE principles. The CE principles will be realised by integrating the environmental approach into business, both at the internal and external levels of the firms. Mena et al. (2014) argue that a firm that only focuses on pollution prevention will actually produce more waste unless the firm takes it to the product stewardship stage, so that the firm is then able to receive the benefits of their waste reduction efforts. Likewise, Graham (2018) argues that pollution prevention, which consists of both reducing energy and waste, has an effect on the stewardship process where there is cooperation between suppliers and customers. This thesis found that pollution prevention with the resource of continuous improvement serves as an antecedent to the CE principles of waste elimination, maximisation of retained value, and economic optimisation. Whereas product stewardship and resource stakeholder integration are antecedents to the CE principles of cascades orientation, economic optimisation, environmental consciousness, and leakage minimisation. And sustainable development and resource shared vision are antecedents to the CE principles of economic optimisation and social responsibility. These will be explained in detail in the following paragraphs.

Not all initial propositions can be verified by the two previous propositions. For example, in Proposition P1c, where the literature indicates that in the context of agri-food supply chains, firms that have continuous improvement will establish environmental consciousness; however, this is not confirmed by all cases due to low environmental awareness of the actors within supply chains, hence the proposition remains unverified.

This thesis shows a relationship between resource stakeholder integration and continuous improvement which is then marked by Proposition P3a. Stakeholder integration will strengthen capability and exhibit the potential to help build new capabilities needed to benefit from continuous improvement. By building mutual relationships among stakeholders, firms are able to improve their capabilities, such as certifying products with government agencies, or NGOs' technical assistance. This is in line with Mishra, Chiwenga, and Ali (2019), and Pakdeechoho and Sukhotu (2018), who argue the importance of collaboration because it allows firms to share knowledge and provide each other technical assistance. This will increase their profits from both an economic and social perspective by improving quality of products. As a lack of collaboration could prevent firms from reaching their full capabilities, firms that improve their internal operational capability should acquire knowledge from higher levels in the supply chains.

Despite all the cases having confirmed that they have made efforts to reduce FLW, the findings indicate that awareness amongst the actors in agri-food supply chains is relatively low. There is little to no recorded data of the amount of waste produced by each firm, resulting in the evaluation of quantitative amounts of FLW to be impracticable. The main reason for this is their primary focus lies on improving the output quality in order to meet consumers' demands, e.g., attaining ideal shapes of fruit and vegetable produce. Another reason is the apparent misconception about food waste and the relatively low food prices that cause food waste to be undervalued. Nonetheless, knowing the amount of FLW produced is vital as this is invaluable in understanding how much food is wasted and the embedded energy and resource usage related to production and transportation (Corrado and Sala 2018).

7.2.2 Circular Economy principles related to food loss and waste

To comprehend CE successfully, it is necessary to understand its fundamental premises, where the most critical parts involve accomplishing goals. CE principles are broad and basic, allowing them to serve as a foundation for the necessary modifications to the unique CE issues faced by each context (Rizos et al. 2016). The CE principle's existence clarifies the direction and goals, allowing for a better understanding of the major issues and guidelines to resolve them. For instance, reusing wastewater methane to generate electricity is consistent with the CE principle of conserving natural resources and substituting renewable sources (Colley et al. 2020). Consequently, without the CE principles, problems become obscure since there are no criteria for prioritising and guiding the resolution.

An important aspect that needs to be considered is that circularity in the agri-food sector has key elements and is idiosyncratic in its approaches, which has made it different from the technical cycle (durable) representing the manufacturing industry (see the EMF (EMF 2013a) butterfly diagram in Chapter 1). Ample research has been conducted on the technical cycle in EMF through the process of reverse logistics, that aims to utilise the products as long as possible through the processes of reuse, remanufacture and recycling. This is due to the distinct characteristics of products in the biological cycle (consumables), and therefore the approach of CE. This research posits that CE adoption in the agri-food sector is measured by the implementation of principles of CE that align with NRBV. Do et al. (2021) argue the need for a thorough discussion of how the principles of CE are translated to address FLW. The work of Ripanti and Tjahjono (2019) who reformulated the CE principles consisting of six main principles: waste elimination, environmental consciousness, leakage minimisation, cascades orientation, maximisation of retained value, and economic optimisation, is adopted. Details of the principles related to FLW are explained in the following section.

The first CE principle is waste elimination. Based on the relationship between continuous improvement and waste elimination, Proposition P2a is constructed where it was stated in the initial Proposition P1a and is confirmed by all cases. In the principle of waste elimination, prevention efforts are carried out so that no waste will be generated (Ripanti and Tjahjono 2019). The findings in this thesis indicated that by forecasting and planning supply demand, the company regulates the production flow of products to consumers (Jabbour et al. 2019, Kalmykova, Sadagopan, and Rosado 2018). In addition, one of the efforts to reduce waste in supply chains is the lean process; which is an attempt to limit the amount of stages in the process of producing food up to the distribution stage. Jurgilevich et al. (2016) devised solutions to cut processes at the production stage by supporting smart agriculture and local food movements in the form of direct sales by growers to consumers with various innovations. As such, the lean process can be implemented.

To optimise efforts in preventing and managing waste, it is important to take measurements (Corrado and Sala 2018). However, most of the actors lack an awareness of the need to record waste as they do not measure quantitatively. In spite of this, accumulated experience is regarded as helping most actors to improve reducing waste by evaluating previous processes. Waste elimination is also related to accurate forecast supply and demand as well as proper handling along the supply chain and certainly requires actors to be well trained at every stage of the product flow. As proper handling skills can be acquired through training provided by firms, with the existence of big data, training can be utilised to support improvement and provide the necessary actions for reducing waste (Belaud et al. 2019, Giudice et al. 2020). Such activities can be repeated until they turn into habits and form part of the company culture. Therefore, firms' culture can also help reduce waste, as it has been confirmed that all cases are proved to have the same commitment to waste reduction. This commitment, especially from managers, will have an impact if it is driven by increasing competencies and capabilities for all employees of the firms (Centobelli et al. 2020).

The second principle is environmental consciousness. Environmental consciousness is described as an effort to encourage environmental conservation with strategies adopted by companies to reduce environmental impacts (Ripanti and Tjahjono 2019). Therefore, this relationship is shown by the presence of Proposition P3c. Previously, environmental consciousness was built on the antecedent of continuous improvement, as indicated by Proposition P1c. This difference occurs because environmental awareness is depicted by the use of reusable crates by each stakeholder to deliver agri-food products from producers to retailers, however this does not take place internally. Despite reusable crates being simple tools, all cases have the same awareness to use them in the process of distributing agricultural products. The use of reusable crates to protect vegetables and fruits in this finding is one of several alternative types of green packaging improvements, in addition to redesigning environmentally friendly products, and creating packaging design systems, all of which aim to help reduce waste and improve products' value (Clark, Trimingham, and Storer 2019, Kazancoglu, Kazancoglu, and Sagnak 2018). Besides using sustainable crates, some cases (A, D, K, and T) have started to use recyclable plastics packaging, reusable shopping bags, and cardboard to replace plastic bags, which are included in the first-level packaging that is directly related to the product, thus demonstrating the importance of being the focus of development towards CE adoption (Meherishi, Narayana, and Ranjani 2019). The development of packaging for CE adoption can be done by improving the size or shape

(Cristóbal et al. 2018), and material, such as compostable packaging made of polylactic acid (PLA) (Borrello et al. 2016).

The third principle is leakage minimisation, which is realised by the integration of antecedent stakeholders' integration, where there is a food safety compliance capability in the form of internal and external audits with certification from associations and is therefore expressed by Proposition P3d. This deviates from the initial framework, which states that shared vision is an antecedent to leakage minimisation, as indicated by Proposition P3a. This difference is because the literature shows that clean technology as part of a shared vision can reduce leakage, while the findings show that leakage minimisation can be implemented not just by optimise cascading food but also by certification and auditing of business processes as a whole. By seeking product certification from various associations such as GAP, organic certification, ISO, Halal certification, HACCP and local government certification, firms will improve the quality and safety of their systems and products, ultimately minimising various forms of damage that can cause leakage (Ormazabal et al. 2018). In Europe, certification is used to build the foundation towards CE such as using ISO 14000 and the Eco-Management and Audit Scheme (EMAS) (Ormazabal et al. 2018). The GRI standard is also employed, which includes 301 Materials standard, 302 Energy standard, 303 Water and effluents, 304 Biodiversity standard, 305 Emissions standard, and 306 Effluents and waste standard (Istudor and Suciu 2020). Efforts to certify are very useful in order for products to be standardised, such as with ISO17025 certification, known as the international standard in Limiting Maximum Residue which allows for agricultural products to be able to enter the export market (Egea, Torrente, and Aguilar 2018). However, for some firms, the certification required for system management is seen as an obstacle (Mangla et al. 2018, Rizos et al. 2016).

The fourth principle is the maximisation of retained value with the underlying antecedent of continuous improvement with planning capabilities. This relationship is shown by Proposition P2b, although, the initial framework previously used P2a to show stakeholder integration as the antecedent for maximising retained value. This difference is due to the fact that the findings show that efforts to maximise retained value are carried out internally by the firms according to their respective capabilities, rather than at the supply chain level. Planning capabilities include the ability of each firm to carry out proper product handling, such as temperature regulation, summarising harvesting systems, and delivery scheduling, which will maintain the best product quality. Maximisation of retained value is the principle used to keep the product as long as possible by minimising the reduction in value through a suitable handling system (Ripanti and Tjahjono 2019). Findings identified that the temperature is regulated in such a way as to prevent overheating and rapid wilting in aims to minimise the reduction in product value. Similarly, Vlajic, Mijailovic, and Bogdanova (2018) emphasise the use of a temperature regulator to preserve agricultural products while in transportation. Contrary to findings, maintaining product value can also be done by optimising local sources so as to shorten transportation routes, optimal selection of quality plants, and suitable packaging designs (Krishnan et al. 2020); the closer distance will ensure the product quality is not drastically reduced.

The fifth principle is economic optimisation, which also has antecedents of continuous improvement and shared vision. Planning capability occurs within continuous improvement. This relationship is shown by Proposition P2c, previously stated as P1b with the same statement on the initial framework. As explained above, economic optimisation encourages activities that generate financial benefits by creating products that have economic value (Ripanti and Tjahjono 2019). Actions are able to be carried out in planning capability by understanding product knowledge. This not only entails understanding the selling value of a product in the market but also the highest economic value a product can reach when entering the processing line (Cristóbal et al. 2018, Mehmood et al. 2021). Optimising economic value can be done by increasing prices on products that harm the environment (Garske et al. 2020). The principle of economic optimisation also encourages firms to increase product value, by turning FLW into various products such as producing derivative products, animal feed (Tedesco et al. 2019), biodiesel (Colley et al. 2020) or by producing biogas as an energy source (Cristóbal et al. 2018, Hoehn et al. 2019, Jurgilevich et al. 2016, Palmieri et al. 2020).

As for shared vision, technological innovation capabilities are exhibited. This includes the adoption of digital technology, such as websites, applications, and social media. Communication using digital technology helps stakeholders to share information about the demands of current social trends. This relationship is shown by proposition 4a. The economic value of a product can be increased by using technologies designed to manage food waste into innovative and high-value derivative products, resulting in new market opportunities and resource efficiency (Egea, Torrente, and Aguilar 2018, Maina, Kachrimanidou, and Koutinas 2017). In contrast to the findings of this thesis, the shared vision is mostly implemented with information technology, which are easier and faster to use than other penetration technologies.

In addition to stakeholder integration, the principle of economic optimisation also has antecedents of continuous improvement and shared vision. Continuous improvement entails planning capability in the form of supply and demand forecasting and internal learning capability in the form of understanding product knowledge and learning from stakeholders. Vision, on the other hand, occurs through technology innovation capability, where stakeholders adopt digital technology such as websites, apps and social medias to communicate and share information on demands of market trends. This relationship is indicated by Propositions P2c and P4a. This finding is in accordance with the statement of Hart, Milstein, and Caggiano (2003) that concludes continuous improvement to be the fastest way to reduce costs and increase profits, resulting in an increase of shareholder value. The company will gain value from the community, as well as reduce waste and operational costs by increasing its capabilities to produce more quality products. Additionally, firms must continue to learn and try to adapt to market needs to survive in competition with other firms. When waste occurs, however, the business could valorise or utilise waste as a resource to be converted into a valuable product.

The sixth principle is the principle of cascades orientation; the antecedent of this principle is resource stakeholder integration, food waste mitigation. This relationship is shown by Proposition P3b, previously illustrated by P2b on the initial framework. The cascades orientation aims to keep the product circulating longer by turning it into another product (Ripanti and Tjahjono 2019). Cascades orientation is associated with economic optimisation for the reason that firms are seeking to generate economic benefit through selling the products to secondary markets, or processed further as value added products; hence, firms that realise the principle of cascades orientation simultaneously realise the principle of economic optimisation. This is in line with De Angelis, Howard, and Miemczyk (2018), who state that cascading material will enter into other channels, to be turned into other products and eventually provide financial benefits. As cascading activities must be carried out with various stakeholders in the supply chain, the findings also found information sharing among stakeholders to determine supply and demand for each company, as it can help to divert agri-food products that are dedicated by modern retailers to other channels such as traditional markets (Teigiserova, Hamelin, and Thomsen 2020).

The seventh principle is social responsibility. This thesis argues that the social aspect is missing in the CE principles; therefore, it is crucial to add one more principle. Social responsibility shown by the supply chain has different degrees of implementation. Both upstream and midstream have similarities in action by giving away food donations and the downstream with other forms of social action. This relates back to the CE definition, that CE can stimulate economic growth, create job opportunities, lower material cost, reduce price volatility and enhance supply security. The social aspect is important in CE; as Padilla-Rivera, Russo-Garrido, and Merveille (2020) stated, CE should benefit society, employment, and participation. Food safety, FLW, food security, and natural resource depletion are all critical aspects of the current problematic issue affecting the agri-food chain as a result of unsustainable food production techniques. As such, It is imperative to move to more sustainable practices, one of which is the demand-based approach that has been attempted by all supply chains. By providing assistance to others in the form of food, money and so forth, what must also be considered is how the recipient of that assistance can respond to the aid properly.

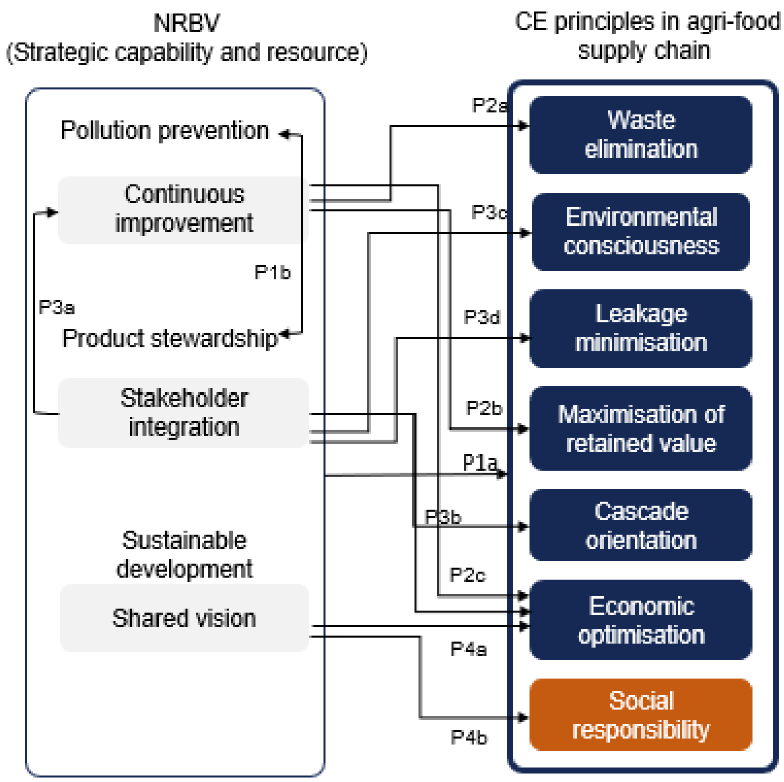

Figure 44 Refined framework with respective propositions

This could be by making the assistance their capital to grow and develop so that firms engaged in the social sector could potentially help resolve the root of the issue as well as adhere to sustainability values. Kirchherr, Reike, and Hekkert (2017); Murray, Skene, and Haynes (2017) argue that a CE definition is missing from other aspects, including the social dimension. Murray, Skene, and Haynes (2017) suggest that the definition should be revised to "an economic model wherein planning, resourcing, procurement, production, and reprocessing are designed and managed, as both process and output, to maximise ecosystem functioning and human well-being". As such, this thesis answers such gap with social responsibility, referred to as involving the community in the business and the concern of firms towards the society in need through food donation, also included as one of the CE principles.

7.2.3 Outcomes of Circular Economy

Four outcomes of the CE have been identified; the main outcome is a decrease in FLW and is supported by all cases A to T as shown in Figure 45. Be that as it may, this thesis can only reveal the main outcome of applying CE principles in reducing FLW, and disclose minor outcomes referred to as outcomes that are only partially supported by the cases. An example of a minor outcome includes leakage minimisation, as preservation of natural resource is only supported by the upstream. Likewise, consequences of social responsibility, namely minimising greenhouse gases, is only supported by C, I, P, Q, and R cases, while helping the local economy is only supported by upstream and midstream cases. Corrado and Sala (Corrado and Sala 2018) stated the importance of measuring the results of implementing food waste reduction as it can then be used as a basis for making appropriate policies. In addition, other studies described assorted tools that can be used as the basis for measuring food waste reduction, such as the category matrix from food surplus, loss and waste, updated food hierarchy and CE framework (Teigiserova, Hamelin, and Thomsen 2020).

An outcome as a result of the waste elimination principle is the reduction of FLW. Each firm shows the importance of forecasting supply and demand and ensuring all products are marketable in order to reduce waste within the firm. In reducing waste, efforts in measuring are as important as it is in the downstream, which measures the waste generated with KPIs, where it is limited to around 5 percent of the revenue. Del Borghi, Moreschi, and Gallo (2020) affirm that there are two important connected steps that must be done, namely efforts to reduce food that turns into FLW and efforts to calculate FLW. Measuring the results of the implementation of food waste reduction is deemed important, as then firms can use the data as a basis for taking appropriate actions (Corrado and Sala 2018). Additionally, many studies have also found a range of alternative ways to reduce FLW. For example, a study by Kazankcoglu et al. (2021) suggests optimising transportation routes for agri-food products and Rodrigues et al. (2021) believes that digital technology adoption can be used to facilitate sales reducing FLW.

The second outcome, particularly standing out in the upstream, is the preservation of natural resources revealed through the principle of minimising leakage. Leakage minimisation can be seen in how upstream has implemented soil management by cultivating the soil using natural nutrients, implementing integrated pest control, and using drip irrigation. These measures are claimed to protect soil natural resources from harmful substances and save water use. The upstream initiative for composting food waste is in fact a form of minimising leakage, so that food waste can be used as soil nutrients. Genovese et al. (2017) stated that the CE principle assumes that there should be no material leakage, ultimately reducing the negative impact on the environment. Furthermore, obtaining certifications is demonstrated by almost all actors to ensure food safety compliance and that no hazardous substance was used. These certifications consist of HACCP, ISO and organic certification. Istudor and Suciu (2020) also mentioned that by certifying, the firms participate in preserving natural resources, which will encourage competitive advantage as consumers are also concerned with nature conservation. This is in line with Egea, Torrente, and Aguilar (2018), Kazancoglu, Kazancoglu, and Sagnak (2018), and Krishnan et al. (2020) who affirmed that by implementing CE, natural resources will be preserved and carbon footprint reduced.

Several cases support the results of CE's social responsibility principles. These cases include Cases C, I, P, Q, and R, which implemented social responsibility by reducing greenhouse gases with reforestation, supporting the global movement towards green and healthy hospitals, and tackle climate change and promote public environmental health through the earth hour movement. Adding on, it is important to involve employee members in a range of social activities, and to participate in environmental movements at global and national levels. This includes the aforementioned earth hour program by turning off unnecessary energy use, hence, spreading awareness in the community which can benefit the firm's reputation.

Another outcome supported by the upstream and midstream regarding community involvement in business is an increase in the economy at the local level. Among the efforts made, this action is in accordance with the principle of economic optimisation, despite being only partially supported; shown by a dashed line. Helping develop the local economy will help companies grow and develop independently. This finding is not commonly discussed primarily due to the fact that it is rarely found in developed countries, therefore, trying to observe the activities of local companies, the findings can uncover other, more tangible, impacts.

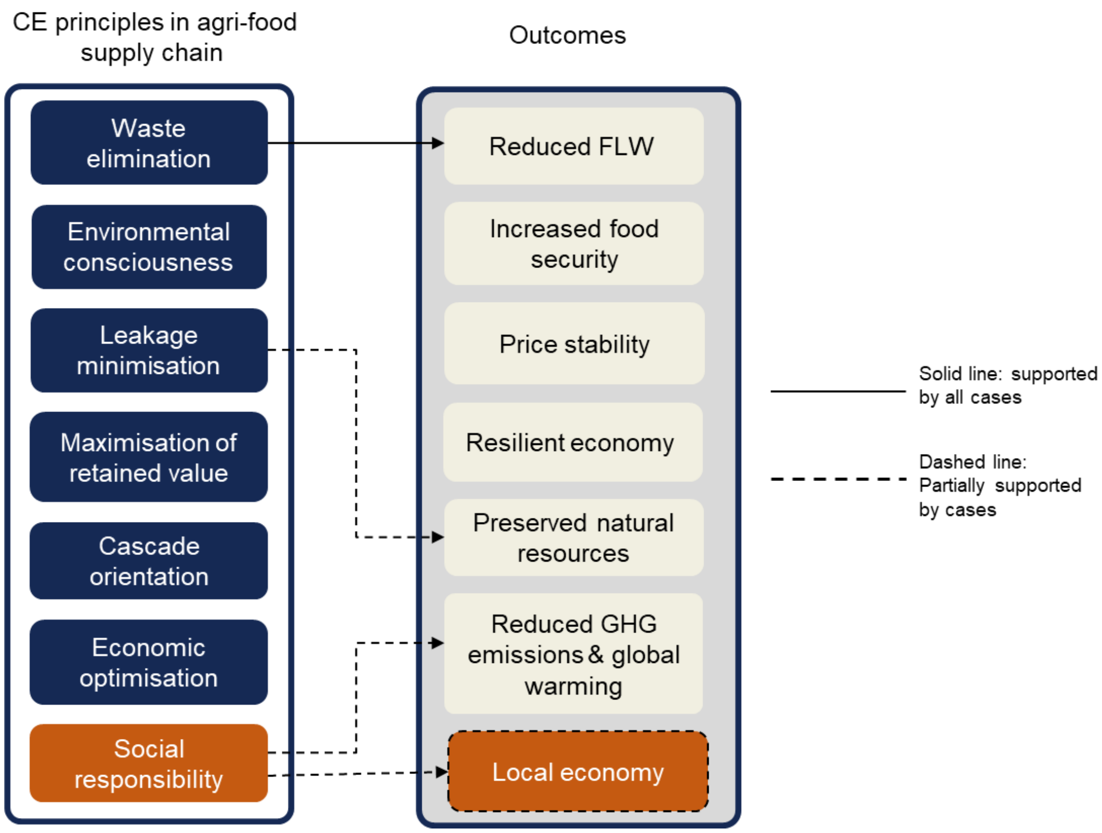

Figure 45 CE principles and outcome

7.2.4 The barriers to implementation of Circular Economy

The barrier in this thesis is described as an obstacle to the implementation of CE adoption, especially in the agri-food supply chain. By understanding the barriers, firms can identify which capabilities are required to overcome the obstacles identified in adopting CE by this thesis; these are classified as knowledge, structural, financial, and supply chain. These findings are shown by the existence of Proposition 5 which reinforces the initial framework. The similarity of findings with some literature can occur due to the similarity of firms' characteristics. However, in the case of developing countries, especially in Indonesia, geographical conditions become its own barrier that has not yet been discussed by literature.

The first barrier is knowledge, where the findings show that all cases have difficulty understanding the term CE. As also stated by Sharma et al. (2019), the lack of knowledge is one of the main challenges to the CE. This thesis highlights the main barrier to CE adoption in the agri-food supply chain as the lack of knowledge, although this may be context-specific due to CE being an unfamiliar term in the developing country. The extant literature on the other hand mainly involves samples who do understand CE. Additionally, other studies reveal that some firms comprehend the term CE to an extent but lack an understanding of its benefits and perceive CE as incapable of assisting them in increasing their profits or achieve sustainability (Ormazabal et al. 2018). It is important for firms to understand the CE concept as it will encourage them to be more receptive to the condition of their company and the strategic capabilities that need to be improved.

A number of recent studies acknowledge the fact that SMEs, especially in developing countries, have yet to know the terms and concepts of CE (Cantú, Aguiñaga, and Scheel 2021, Mangla et al. 2018, Rizos et al. 2016). One reason for this is because SMEs have difficulty in finding information regarding CE (Mura, Longo, and Zanni 2020). Moreover, understanding the CE concept was also found challenging by SMEs because of the lack of encouragement from a managerial level to understand the concept and the absence of the best practice that can be used as a role model to implement CE (Sharma et al. 2021). Whereas Imran et al. (2019) suggests that to be able to have innovation capabilities, such as reorienting a firm towards a CE, firms need access to information facilitated by the role of a manager.

Ripanti and Tjahjono (2019) highlighted the importance of understanding the term of CE to be able to implement the required CE values that comprises all aspects of the CE system. This is done through actors familiarising themselves with the general terms and concepts of CE. These values are divided into three types: principles, attributes, and enablers. Principles are basic values that become the most important points of a system that can direct development to stay on the main goal; attributes are considered as the characteristics of a system that determine, as a consequence of logistics, the realisation of the concept of a system; and enabler is a value that encourages and supports the construction of the system so that it is in accordance with what is aspired to. One of the important values for CE implementation is to establish CE as not just transactional but also as a system built on collaboration. According to Ripanti and Tjahjono (2019), collaboration is a CE attribute that characterises the CE system. Whereas Mishra, Chiwenga, and Ali (2019), believe collaboration to be an enabler for the establishment of the CE system, suggesting a lack in agreement in defining the CE concept.

The second barrier is structural, which occurs due to land contours, climate, and weather factors. The erratic conditions of the land or the weather come from factors that cannot be controlled, however, this barrier is rarely found in literature as a significant problem. Moreover, looking at the geographical conditions of Indonesia, with most of its products suited for a tropical climate, SMEs do not have excess funds to build greenhouses or purchase other technologies that can minimise the impact of climate on their cultivation system. Therefore, climate constraints often can only be overcome by the firm’s financial ability.

The third barrier commonly faced is financial barriers. Financial ability was found as one of the major obstacles firms face in adapting to the needs of the transition to CE by investing in continuous improvement and technology. This is largely due to a substantial investment needed to invest in innovative technology, conduct human resource training, or build awareness within the community, with a wide range of marketing and intelligence strategies. These barriers are generally seen in the literature, where SMEs and companies in developing countries are hampered by a lack of financial capability (Ali et al. 2021, Gedam et al. 2021, Scipioni, Russ, and Niccolini 2021). They are also hampered by financial infrastructure such as banking systems and financial services (Cantú, Aguiñaga, and Scheel 2021). This makes it difficult for firms to apply more advanced technology to implement CE, forcing them to ultimately continue to run a linear business model (Ali et al. 2021, Gedam et al. 2021, Sharma et al. 2021). The financial barrier may be resolved by encouraging the government to develop policies and incentive assistance for companies involved in CE implementation programmes, which can also open the way for investors from big companies to build and develop infrastructures needed for CE implementation (Kirchherr et al. 2018).

Based on the findings, the upstream supply chain is dominated by small companies, which, according to London, Anupindi, and Sheth (2010), displays characteristics of having financial constraints, resource constraints, and a lack of both technology and experts. Furthermore, they explained that small companies face obstacles regarding the difficulty of market access, particularly in knowing market preferences or needs. Additionally, small companies are often manipulated by intermediaries and lack alternative markets, so demand remains uncertain. This is similar to this thesis' findings; in which despite shared experiences and exchanges of upstream with both midstream and downstream, there were still issues with visibility of demand, causing food loss and waste.

The fourth barrier is the supply chain. The findings indicated that the standard operation procedure of modern retailers need to be reformulated, because retailers are deemed to be the controllers of distributors and growers in addition to having greater resources over other actors in the supply chain and have access to end consumers. Similarly, Rizos et al. (2016) revealed barriers in the supply chain due to the lack of support from other supply chains. Henceforth, development on managing food waste and the use of unsustainable packaging could enforce retailers to obey the law and consequently become environmentally friendly, ultimately achieving sustainability. This finding corroborates the study of Ashby (2018) regarding focal firms that have the power to regulate other actors in the supply chain. Incentives through tax reduction could be given to retailers that implement the recycling of their waste and use sustainable packaging in their operations. By providing such incentives, retailers can force distributors and growers to support modern retailers. A business opportunity is then presented by creating new actors in the supply chain to re-distribute waste into the upstream as nutrients for crops. This has not been considered previously by retailers due to doubts and high concerns for firms' reputation.

Moreover, this should be considered as an opportunity for firms for its trajectory towards gaining a positive reputation as well as create a competitive advantage because they have implemented businesses that integrate an environmental strategy into their operations. Despite the lack of trust in third parties to redistribute food to the community where it is needed, retailers should not limit their charity programmes to food waste as it would be unethical from a social viewpoint. Therefore, more actors in the supply chain who are able to manage this social activity are needed, as to potentially become a well trusted legal body.

As customers today are aware of sustainability, modern retailers will gain a positive reputation through being environmentally friendly, and this in turn will be correlated to the triple bottom line. This resonates with the literature on the barriers (Kirchherr et al. 2018) who claimed low market interest to be one of the barriers of CE, therefore when the market is more ready to face the change towards CE, the chances of CE's success to be implemented will be even greater. Hence, there is a need for policies of modern retailers that have implications for environmental tensions, social values and ethics in the market. In line with Hart (1997), a shared vision is needed for sustainable development by minimising environmental impact and demonstrating a strong engagement with external stakeholders, which should open up future opportunities and gains from a stabilised capability growth for long-term competitiveness. In addition, it is relevant that the actors involved are in the agri-food supply chains.

Visionary firms should be able to drive towards CE and be able to redesign and redefine their firms (Hart 1995). A fundamental change is required in the attitude of actors in the supply chain in order to foster CE. One of the respondents of case U stated that it is possible for CE to be implemented in Indonesia; however, such future is in the hands of the younger generation or millennials who are willing to learn, are fast learners, and more knowledgeable in terms of technology. As the following excerpt indicates:

> *"We rely on the young, millennials, they are adaptive to technology, fast learners, they are really the agents of change. The older generation is not keen to adopt new knowledge." (U-1).*

Several problems identified in the findings should not make firms remain static, but they should rather recognise benefits and positive impacts for the future; these obstacles should be used as challenges that need to be resolved immediately by identifying with more in-depth research and include various alternative solutions in order to achieve a CE.

7.3 The applicability of the circular capability framework

The circular capability framework that has been constructed is derived from the specific context of agri-food in a developing country. However, the case samples for this thesis have been carefully selected, involving structured markets from upstream to downstream represented by modern retailers, and omitted other distribution channels such as food industries, hospitalities, and traditional markets. The thesis argues that a Circular Capability Framework can be applied in the broader context, including in developed countries, as they also possess a structured market.

Developed countries have long enforced regulatory policies to encourage the implementation of CE as they realise its benefits; improve the economy, reduce greenhouse gases, promote the evolution of a new industry, create job opportunities, and efficient use of natural resources. Whilst the developed countries have higher literacy and understanding of the CE concept compared to the developing countries, a strong incentive to fund and further research CE is proposed, where significant commitment is spent into developing such policies and appropriate infrastructures. This entails designing a system that allows restructuring the way food is produced, selecting raw material that can easily be composted, as well as providing food donations, food banks and an established waste management system. A strong and supportive relationship across the supply chain is then maintained as an enabler to implement CE effectively. Another distinction observation between developed and developing countries is that the developed countries uphold the habit of waste recording quantification to ensure improvement in the efficiency of natural resources and limit environmental impacts such as the production of greenhouse gases. Moreover, consumers in the developing countries arguably have higher tolerance and awareness towards consuming products below specifications, which to some extent contribute to reducing waste at the production level, but this is challenging in developed countries. In addition, frameworks such as the waste hierarchy can be implemented more effectively in developed countries, because developing countries experience more prominent cascading principle where products can be easily diverted to other distribution channels to fulfil economic motivations.

However, there are conditions that must be considered in its application to the broader context, whilst capability as the outcome of some CE principles remains underexplored. It is worth noting that the results demonstrated that all cases supporting the application of CE can be identified as having the outcome of reduced FLW. This could be due to actors within the supply chains paying less attention to recording waste occurrence and conducting evaluation, as they are still concerned more about productivity and profits, that in return, are considered to be able to compensate for the loss and waste. A possible explanation for the fact that the outcomes of CE principles were unable to be fully disclosed in this thesis is the lack of knowledge on CE in the samples used in this study. Despite unfamiliarity with the term CE, however, all the actors exhibited the cascades orientation to optimise economic benefits, where they are in fact manifestations of CE principles. When compared to research using samples in developed countries where they might have implemented CE as part of the company's implementation, identification and measurement can be considerably more straightforward, in which results can be found from implementing CE as seen by the research conducted by Frodermann (2018). As such, it is possible that CE outcomes can be easily identified in the context of developed countries, whose environmental awareness is better, and therefore further strengthening the application of this framework.

Another point to consider is the barriers between developed and developing countries. Additionally, identifying barriers has been expressed in this thesis, with lack of knowledge and familiarity of the term CE being a significant barrier for CE adoption as seen in most of the samples. Another case is that research is more extensive in developed countries where barriers are particularly burdened on the high costs of changing a system. The literature showed that the sample used in most studies is in the context of developed countries, such as Frodermann’s (2018) research that uses sample firms in developed countries that has implemented CE, so application of CE is easier to identify regardless of the obstacles that are still being faced. However, the difference does not mean that the Circular Capability Framework cannot be used in other contexts such as developing countries, as it is open to customisation for other supply chain contexts with some adjustment to capabilities and the mapping to the relevant CE principles.

7.4 Contributions to knowledge

The findings of this thesis have several contributions to the current academic research, which will be explained in the following paragraph. This thesis expands the literature in four ways: by using a new perspective in CE research; elaborating on the theory of NRBV and the CE concept which has emerged significantly in line with various sustainability outcomes; contributing to empirical research in sustainable development, conceptualising a Circular Capability Framework for tackling FLW, and identifying several obstacles in implementing CE.

First, this thesis offers a new perspective on CE research and contribute to a wider supply chain literature by using NRBV as the theoretical lens. Using case research for theory elaborating, help to identify the relationship between constructs of NRBV and CE principles in tackling FLW issue from a critical realism standpoint. This thesis discovers the capabilities needed for tackling FLW contribute to expand NRBV literature. The research specifically selects case studies in developing countries to observe the capabilities within each resource in NRBV that resembles CE principles. Whilst extensive research is conducted on developed countries such as Europe or China (Mehmood et al. 2021), this thesis observed CE in a developing country, thereby contributing new insights and a deeper understanding of the CE concept and its implementation. Although there have been studies showing a relationship between NRBV and CE (Caldera, Desha, and Dawes 2018, Mishra, Chiwenga, and Ali 2019), none of them have described NRBV as antecedents for CE principles in overcoming FLW issues in the agri-food supply chain.

Second, this thesis explored capabilities of sustainable development in the supply chain, which comprises of economic and social concerns. Based on this empirical research, an unanticipated finding was disclosed; in which the adoption of technology is in fact not always associated with advanced technology, but also digital technology. The few cases that showed application of technology are not as advanced in terms of reducing environmental impacts, with the exception of reusing wastewater and wastewater treatment. A reason for this may be because products of the agri-food supply chain are regarded as commodities that require additional investment, which are highly dependent on selling price, resulting in actors avoiding such investments. Additionally, the adoption of advanced technology is often considered by actors in the supply chain if there are external pressure from customers, market and the government. In this case, sustainable development cannot be path dependent upon two other strategies, pollution prevention and product stewardship, and instead become an interdependent strategy (see Figure 6). As mentioned by Hart and Dowell (2011), advancing technology is deemed as a leapfrog or disruptive innovation that may not create a direct impact on the performance of the firm, and all actors within the supply chain confirmed that they are labour intensive and could generate economic scale issues. With social concern on the other hand, the thesis concurs with the study of London, Anupindi, and Sheth (2010), in which businesses create mutual value creation from the community that falls under based of pyramid producer for poverty alleviation. Reasons for this include inclusivity being a part of the business, in order to focus on generating profit from the new market and as part of the actors within the supply chain.

Third, this thesis contributes to the literature by conceptualising the Circular Capability Framework. The framework is constructed comprehensively with a unique analysis, comprising of the upstream, midstream, and downstream of supply chains in the agri-food sector, and built using empirical evidence with a new theoretical perspective for the framework to be able to contribute references for relevant literature on agri-food supply chains in a CE. This thesis discovers the manifestation of CE principles that have been explicated through literature studies by Ripanti and Tjahjono (2019), and augments a new principle, i.e., social responsibility that needs to be integrated along with other six principles. Social responsibility is therefore proposed, defined as involving the community in the business and the concern of firms towards the society in need through food donation. Moreover, the criticism of the omission of social dimension within CE indicated by Murray, Skene, and Haynes (2017), is thus answered by involving social orientation into part of CE principles. Although this thesis does not measure how firms could benefit from social orientation, some outcomes suggest that involving a wider community in the business will in turn improve the local economy. This stands out from most of the existing literature because it focuses on the agri-food sector which has not been widely studied, where most studies propose solutions for the readmission of waste and by-products. Accordingly, this thesis also contributes to the biological domain of CE by identifying the cascading process to optimise the economic value as guided by EMF (see the EMF (2013a) butterfly diagram in Chapter 1), especially in the context of developing countries. Therefore, this research is deemed appropriate to be the basis for further research that intends to develop CE research in the agri-food sector.

Fourth, this thesis identifies barriers that prevent actors from moderating their ability to implement the capabilities of NRBV as the antecedents of CE principles. As such, barriers may obstruct the NRBV from influencing the implementation of CE principles. The most dominant obstacle being the lack of knowledge as to what CE is and growers associated with integrating farming. Integrated farming differs from CE, because CE is a regenerative system intentionally built by design to preserve natural resources. Whereas integrated farming involves, for instance, the use of food waste as animal feed and livestock manure as fertiliser in a farming and animal husbandry localised in an area. Furthermore, SMEs in developed countries experience barriers in the form of insufficient encouragement from supply and demand networks and inadequacy of both capital and government encouragement (Rizos et al. 2016). On the other hand, developing countries faces a major barrier from lack of knowledge of CE, despite cascades orientation appearing more significantly. In addition, there are several other impediments such as structural problems, limited finance, low environmental awareness, inequality of power in the supply chain, insufficient development of technology, culture, and minimal support from the government. These findings enhance a deeper understanding of the barriers to implementing CE in the context of a developing country.

7.5 Contribution to practice

In addition to the implications for knowledge as described in the previous section, some findings for practitioners are also provided. This thesis found a refined Circular Capability Framework which includes the principle of social responsibility and its relationship to several NRBV capabilities, along with the finding of outcomes practising the CE principles and the barriers that hinder the realisation of the CE principles and outcomes.

Therefore, this research contributes to creating a Circular Capability Framework, i.e., a framework for implementing CE in the agri-food sector. This Circular Capability Framework can be an alternative for practitioners who are managers of firms that are involved in the agri-food supply chains, specifically to overcome FLW issues and progress towards effective product stewardship. It includes capabilities that can be used as considerations for practitioners to implement the firm's readiness to realise CE, allowing firms to be able to make decisions for their development towards sustainable practices. Therefore, this framework can deploy into practical workbook. In addition, with a framework that covers the supply chain stages, practitioners can also determine collaboration with other stakeholders who have capabilities in accordance with this framework. Furthermore, by providing guidance on the expansion of product stewardship, social responsibility can then be prioritised through socially responsible firms protecting the environment whilst empowering the community to improve their welfare.

This thesis has identified several obstacles faced by the practice of moving into an agri-food CE, which can be a reference for managers to be able to build capabilities in anticipating barriers that may occur, such as the lack of knowledge on CE, minimal support from the government, insufficient community culture, low environmental awareness and limited finance. Therefore, in addition to obtaining ideal outcomes for firms in implementing CE, the obstacles are as important to be well understood. These results can be used by practitioners to manage company resources as well as possible and be mindful when making policies.

The range of outcomes articulated in this thesis are useful for practitioners to know the benefits they can obtain from applying CE principles. This thesis can be used as a reference for extended stakeholder groups who may work together to realise CE. The case sample selection in this thesis has been carefully selected, involving a structured market from upstream to downstream represented by modern retailers whilst eliminating other distribution channels such as the food industry, hospitality, and traditional markets. However, structured markets also exist in the context of developed countries, in which this thesis argues that the Circular

Capability Framework could likewise be applied in a wider context, such as in developed countries with appropriate capabilities.

In a larger scale, the thesis contributes to the realisation that there is a need for government intervention in the form of a regulator by providing knowledge and legal regulations, in aims to improve the pace of adopting the new system. This also pushes the narrative for the government to establish a CE model so CE can be implemented in practice, which is especially useful in the context of the study of developing country with a high population.

7.6 Summary of discussion

This chapter evaluates and reflects on the achievement of research question and objectives, as well as highlighting the key findings exploring the operational capabilities that are contained in each resource of the strategic capabilities. Additionally, resources of NRBV were highlighted as the antecedents of CE principles. The cross-case analysis presents the refinement of the framework, namely the “Circular Capability Framework”. The thesis contributes to theory of NRBV by applying in the context of adopting CE in the agri-food supply chain and extending the application of NRBV into the unique of unit analysis at different stages of the supply chain. Therefore, the circular capability framework is derived from different stages of the supply chain in order to have a comprehensive view. The following chapter presents the conclusions of this thesis reached through a research summary, which includes a discussion of the contributions to theory and practice, highlighting the limitations of the research and identifying potential avenues for future research.

CHAPTER 8 CONCLUSIONS

The issue of FLW is focused upon in this study due to its negative impacts towards the environment, economy, and society as a result of wasted natural resources during food production in the upstream to downstream of the supply chain. In particular, the developing country, Indonesia, is investigated, because its position as the world's fourth most populous nation is one of the reasons why they face implications in food security, and the efforts the nation makes to transitioning towards more sustainable practices provide substantial incentive to conduct research. As such, the CE has been chosen as a concept worthy of investigation, as it offers a promising approach for overcoming FLW. The philosophical stance adopted is set as the foundation of the thesis in answering the research question. Consistent with the critical realism language, the analysis process is abductive-retroductive reasoning in balance. The epistemology assumption is retroductive to discover the underlying mechanisms and to explain observed regularities in the context of the agri-food supply chain discussed in section 2.1. The iterative process involves data and theory in equal proportions, allowing theory to be elaborated in order to provide a plausible explanation. Furthermore, a multiple case study is chosen for the purpose of gaining a deep, insightful understanding of the CE, which is considered to be in the early stage of its development.

The previous chapter explained how the findings relate to the existing literature, thereby making distinctive contributions to knowledge and practice. This concluding chapter further reflects on the thesis, employs the theoretical lens to answer the research question, and provides insights for future research. Key findings in relation to the research questions are presented in section 8.1, with section 8.2 discussing the NRBV theory in CE research.

8.1 Key findings

This thesis attempts to answer both conceptual and practical gaps identified in the literature through the following overarching research question:

"How do the agri-food supply chains in the developing world adopt CE to tackle FLW, and what capabilities and resources do they need to possess?"

The question aims to elucidate the causal mechanism of CE adoption that draws from the NRBV theory. The initial framework is used as a guide to set the boundary of research through an exhaustive process of systematic literature review, and some hypothetical propositions also developed showing the relationship between the NRBV and CE. The systematic literature review method is utilised in this thesis to generate the research question. Through exhaustive research, the validity of research and synthesising the NRBV and CE produce the initial framework in the agri-food supply chain. In answering the research question, this thesis divided following objectives:

1. To identify the operational level of capabilities in the agri-food supply chain
2. To explain the relationship between the resources in the strategic capability and principles of CE
3. To identify the barriers of CE adoption in the context of the agri-food supply chain
4. To propose the CE adoption framework that is contextualised grounded in strategic management theory Natural resource-based view theory

The first objective is accomplished through the process of retroduction or redescription of the theory and finding actions at the operational level, which are then classified into a higher level of operational capabilities. By conducting within-case analysis, individual cases explain the operational capabilities that have been implemented. The findings demonstrate that the upstream perceives that the quality of seeds, planning, and good maintenance during cultivation are the most critical factors in preventing waste and are the main factors in achieving high-quality products. By producing high-quality products according to the target market, products can be sold at a high value, and minimise the possibility of waste occurring, thereby optimising economically. Unless an uncontrollable situation happens, such as weather disturbance and oversupply in the market, growers remain confident about anticipated waste. With most growers realising that they produce varying grades or specifications and understand that there are different avenues they can access, they are able to classify their products based on the distribution channels as a manifestation of cascades orientation. Whereas the general pattern at the midstream is to have a strong partnership with growers to ensure supply, which enables distributors to supervise and monitor that product are growing optimally to meet the specifications based on market requirement and reduce lead time. Furthermore, with the downstream being made up of mostly big corporations, which realise everything is measured by economic performance, operations are regulated and bonded by the standard operating procedures in controlling waste that will impact economic loss. However, in the downstream, this approach accounts for ineffective waste mitigation and inflexible cascade processes, resulting in loss of nutrients and environmental impacts due to poor landfilling practice. Although this thesis did not find quantitative outcomes that can be explained by the implementation of waste prevention, all firms in the agri-food supply chain admit that they are able to reduce FLW. Through cross-case analysis, the general patterns in the supply chain are pollution prevention, product stewardship, and sustainable development. Within pollution prevention, continuous improvement is exhibited, which entails operational capabilities of planning, operational process, control, learning process, and culture. In terms of product stewardship, stakeholder integration is displayed, consisting of operational capabilities of information sharing, high order learning, food safety compliance, using sustainable material, and food waste mitigation. Additionally, sustainable development demonstrates shared vision, shown by the operational capabilities, digital technology, and social cohesion. Moreover, the findings also suggest an interdependent relationship between pollution prevention and product stewardship. This differs from Hart (1995) who states that the relationship between them is path dependence.

The second objective is achieved by mapping the resource in each of the strategic capabilities of the NRBV with CE principles. The discussion on the CE in this thesis is based on the systematic literature review conducted in Chapter 3, which contains a meta-analysis and summarises the understanding, principles, outcomes, and barriers of the CE concept in the agri-food supply chain. Henceforth, the observations demonstrate that each NRBV capability is, in fact, an antecedent of CE principles in the agri-food supply chain (see Figure 43). Adapting the works of Ripanti and Tjahjono (2019), who reformulated CE principles, this thesis contributes by adding one principle to be integrated as part of CE principles, that is, social responsibility that emerged from the data set. This was raised from the perspective that if the CE could optimise both economically and environmentally, it should also be able to address social aspects. The deployment of social responsibility, which is popular within upstream and midstream, are in the form of food donations and community involvement. However, this thesis discovered that modern retailers do not participate in food donations due to a history of misuse by recipients, which could potentially risk a company’s reputation and business continuity. Instead, modern retailers display social responsibility in the form of aiding orphanages.

The third objective is achieved by identifying barriers; all cases confirmed that knowledge, structural, and financial constraints become the major challenges. Barriers faced in implementing a CE were also discussed in the systematic literature review, in which they are collected and categorised based on common characteristics. The barriers are further elaborated by literature exploring obstacles in applying strategic capabilities and compared with results of empirical research. Most actors being unfamiliar with a CE, particularly on how to implement a CE, caused loss of opportunities to optimise the use of natural resources and maximise cascade usage of biological materials, as well as ineffective leakage minimisation to use waste as a nutrient in the stages of distributors and retailers. This suggests the need to connect the missing link in managing waste at the end of the supply chain. The structural market conditions also significantly affect the adoption of the CE, particularly for growers who are in a downstream position and extensively use natural resources, encountering many challenges and uncertain conditions. The invisibility of demand makes them struggle with the price, resulting in a reluctance to adopt a new system. This thesis’ research found a conundrum of product specifications. For the growers, high product specifications result in waste that cause a strain for growers; on the other hand, in the interest of modern retailers, growers also want to provide the perfect product for customers and compete with other retail channels, such as traditional markets, so that products do not become waste.

The fourth objective is achieved by refining the initial framework that has been proposed as an outcome of a systematic literature review. The framework explains how the strategic capabilities of a NRBV, in particular to its resources respectively, influence a CE adoption. The resources are identified as the antecedents of CE principles. Previously, the framework was built based on the initial propositions described in Chapter 3 (see Figure 11). However, as illustrated at the end of Chapter 6 (see Figure 42), the framework was refined as a result of the empirical research that was analysed using within-case and cross-case analysis. The proposed framework is contextualised and grounded in strategic management theory, the Natural Resource-based View theory, and outlines a set of propositions that have been explained qualitatively. The framework provides a clear adoption method of the CE in tackling FLW within the particular context of the agri-food supply chain, so-called a Circular Capability Framework.

8.2 Reflection to theory of natural resource-based view in Circular Economy research

Having conducted the empirical research, a reflection and evaluation of the NRBV theory is able to be formed. Whilst most of existing literature measures how the strategic capabilities in the NRBV contribute to environmental performance, this thesis proposes that the NRBV is a theory worthy of use in relation to environmental strategy. This thesis' significant contribution argues that the NRBV is an appropriate theoretical lens to deliver for research on CE, thereby extending the application of the NRBV theory into the phenomenon of the CE, partly focusing on identifying the antecedents of CE principles operating in practice. The NRBV theory suggests that one of the primary drivers of corporations developing new resources and capabilities will be the limits and opportunities posed by the environment. Although some literature acknowledges the benefit of environmental strategy and the importance of integrating the environment into the corporate strategy, this thesis demonstrates that most actors are less aware of the need for an environmental strategy and are more understanding and realistic of other factors such as fluctuating prices. As such, most of the actors prioritise economic performance above all, as they realise a firm's pay-off is not sufficient and needs substantial efforts to be realised. Furthermore, as discussed in section 7.2.4, one obstacle as to why firms avert their concerns towards their effects on the environment is due to the lack of support from actors within supply chains and government. Meanwhile, the long-established and practiced linear system supports said stakeholders, who are necessary to transform to a circular system. Therefore, product stewardship is not ideally shown to follow the life cycle approach for the creation of the product design that facilitates the composting process, as the use of unsustainable packaging remains predominant, creating another waste stream that needs to be solved.

Despite this thesis illustrating all the cases that do not ideally implement environmental strategy within firms, the researcher argues that strategic capabilities of pollution prevention and product stewardship are interconnected strategies and are not path dependent. Firms' internal operations benefit by establishing extended relationships with other firms or external organisations. This is demonstrated by upstream actors who have collaborations with many organisations and, consequently, gain knowledge through the learning process in the product stewardship strategy, which is useful for improving firms' internal operations.

The capabilities that have been demonstrated by the case samples are manifestations of CE principles, and therefore the NRBV should be incorporated into theorisations of CE within the strategic management. Thus far, the importance of this relationship has not been recognised sufficiently. The NRBV should be acknowledged by academia as one of the CE philosophies along with cradle to cradle and biomimicry to serve as a foundation of the CE. Specifically, product stewardship strategy suggests firms take an environmentally proactive stance towards raw material and component suppliers, with the goal of decreasing the entire supplier system's environmental impact. Close collaboration in supply chains and engagement with stakeholders appears to be necessary if the environmental impact of the product in use is to be minimised and the used product reused or recycled. In this case, it is the attitude of the actors involved in implementing a food waste mitigation strategy that demonstrates the cascades' orientation.

However, in the context of agri-food in a developing country, sustainable development, referring to the NRBV theory (Hart 1995), which comprises of clean technology advancements and alleviating social issues, is not as relevant. This is because the use of advanced technology is deemed unfavourable due to the limited advanced technology available, requirements of substantial investment that are not feasible, and that agriculture is not considered as a pollution contributor compared to the manufacturing industry. The absence of advanced technology demonstrates the limitation of the NRBV. All the cases agree that advanced technology that may reduce environmental impacts does not always provide benefits, but that the use of digital technology brings advantages in sharing information and adopting the digital farming system, as discussed in Chapter 6.

Another limitation of the NRBV is the conceptualisation of the social value of the firms within a sustainable development strategy. Unlike with manufactured goods where global firms are able to adjust production to make products more affordable, in the context of developing countries, especially, agri-food producers are not able to dispute prices of commodity products that are prone to fluctuations in general. Consequently, the social view within the strategic capability of sustainable development in the NRBV theory (Hart 1995) is deemed not feasible. Therefore, the strategy should be replaced by the adoption of digital technology and social value of the firms, appearing in the form of community involvement in the business and food donations as part of implementing CE principles to reduce FLW. This thesis, thereby, augments social responsibility as one of the CE principles to be integrated along with existing CE principles. As a contribution of this thesis, the referred to idea of social responsibility differs from a previously established definition, having emerged from the interpretation of the empirical research conducted. Social responsibility in this context is defined as involving the community in the business and the concern of firms towards a society in need through food donations, which has been discussed in section 7.2.2.

Whilst it is evident that extensive research is more established in the manufacturing industry and developed countries, the CE has been integrated into the strategic vision of the firms. In addition, several firms in countries that have recognised and pledged to being strategic nations have set actions and complied with policies, such as those promoted by the European Union. Conducting empirical research in the context of a developing country entails more challenges due to a lack of familiarity with the CE, leading to difficulties in attempts to adopt CE principles. Actors within the supply chains still struggle to secure economic performance due to uncertainty of demand, fluctuating market price, and high expectations of perfect product specification, although the actions exhibit one of the principles of the CE such as cascades orientation.

As presented in Chapter 2, this thesis utilises case research for the purpose of theory elaboration (Ketokivi and Choi 2014). Then, to evaluate whether this thesis has sufficiently contributed to theory, Whetten's (1989) outline consisting of criteria questions is used. First, "what is new?". The CE phenomenon is accentuated in recent years as a result of numerous empirical and conceptual studies due to concerns of resource scarcity and environmental impacts. Each sector, however, has its own distinct characteristics. The CE deemed agriculture as one of the industries producing food unsustainably, particularly because of FLW. As a result, this thesis provides fresh light on the NRBV capabilities required to implement CE principles in agri-food supply chains. The principles outlined in this thesis are the outcome of the observation of general principles relevant to the agri-food sector that are directed toward resolving the FLW issue.

Second, “so what?”, entails whether the research helped to overcome deficiencies in current theory. This thesis contributes to knowledge by extending the NRBV theory into the CE phenomenon as an intervention to overcome FLW. The findings of this thesis have the potential to improve the NRBV theory in several ways, including the way the NRBV is used in the CE phenomenon, the relationship between its resources, and the NRBV capabilities found in the agri-food sector. All of these findings have an effect on the theory, allowing it to be more effectively and practically applied to the firm's existing factual situations. For example, by juxtaposing the NRBV with the CE principles, this thesis can broaden the view of the NRBV and sharpen its application to environmental challenges and natural resource depletion. Additionally, by understanding the interdependence of pollution prevention and product stewardship, firms will have better understanding in determining the appropriate strategy to overcome FLW based on its capabilities and conditions, as opposed to path-dependence, which requires the company to begin with applying pollution prevention strategies. Finally, by conducting empirical research, namely investigating the details of the firm's capabilities that are part of the NRBV, the result will be a more robust Circular Capability framework than if the thesis remains purely conceptual.

In addition, this thesis contributes to practitioners by providing a Circular Capability Framework, which explains the various capabilities required as an antecedent of the CE principles and the outcomes of implementing the CE principles. Practitioners who are more proactive in their attempts to implement a CE will benefit even more in seizing the opportunity to contribute to the solution of the FLW. This thesis will not only reveal the capabilities and positive relationship between the NRBV and the CE principles, but also reveal the barriers to the NRBV that act as an impediment to the CE principles being exhibited. The findings addressing the development of the NRBV theory in the agri-food supply chain can serve as an opportunity for further research by academics seeking to apply the NRBV theory to environmental and organisational issues. For instance, by extending this research and determining the quantitative value of the propositions.

Furthermore, the agri-food supply chain involves stakeholders from upstream to downstream, including companies, governments, and NGOs, which suggests the critical nature of the involvement of each stakeholder in implementing the findings of this thesis to realise a CE. Therefore, the results of this thesis suggest varying steps that can be taken by stakeholders. First, companies that are engaged in the upstream, middle, and downstream stages must have continuous improvement resources within the company's internal operation. Every company can start by forecasting supply and demand, cutting out ineffective paths, and committing to prevent FLW waste. The implementation can be optimised by conducting training for company employees, as having higher skills in product handling will lower the waste generated.

This is followed by trying to apply the three strategic capabilities of the NRBV in the company, which will encourage expanding broader knowledge and improve the capabilities needed to fulfil the principles of a CE. However, obstacles arise from the lack of understanding of the required capabilities along with the absence of role models, making the CE concept abstract and difficult to implement. Therefore, the role of company managers is very important to provide guidance for employees about the capabilities and processes that need to be followed. In addition, companies need to build communities and work together to exchange information, collaborate, and evaluate each other. Cooperation can be built by companies at the same or different levels. They can also collaborate with other credible institutions such as universities or research institutes.

Moreover, for Indonesia, where the agricultural sector provides 87% of the raw materials, provides food for 270 million Indonesians, and contributes around 13.7% of Indonesia's GDP (Badan Pusat Statistik 2021).Therefore, communicating with external parties will be a substantial influence. Similarly, the government can also establish relationships with other countries that have successfully implemented a CE, which will help resolve issues relating to insufficient information, role models, and access to technologies that constrained firms from exhibiting NRBV capabilities. Communicating with other countries, collaborating, and recruiting experts in the field are a few measures that can be done by the government to mitigate FLW problems by implementing a CE in the agri-food supply chain.

Corresponding to the findings in this thesis, the government's role in making policies is also needed. This requires the government to be responsive to the latest research developments and observe current needs of the community in order to make the right policies. For instance, a master plan containing government steps in developing CE-based agriculture can be designed to be used as a reference for the development of agricultural systems. The government can also support company standardisation such as providing incentives for companies that follow ISO, GAP, or HACCP standards. Additionally, special regulations regarding FLW in the supply chain will not only manage companies directly, but also further raise awareness of the issue. Even so, the lack of government support itself will present predicaments, which slows efforts to address FLW problems in the agri-food supply chain.

Third, “why so?” refers to whether the underlying logic and supporting evidence demonstrated are compelling, built on a foundation of convincing argumentation, and if they are grounded in reasonable, explicit views of human nature and organisational practice. The adoption of the CE using the capabilities of the strategic capability of the NRBV can be achieved considering the NRBV is the antecedent of CE principles. The current practice of the linear economy is deemed irrelevant. The linear economy has contributed to multiple issues of environmental damage, irresponsible exploitation of natural resources, and threatens sustainability in the future. This thesis has used the NRBV theory that generated a set of initial propositions to describe the relationship between resources in the NRBV and CE principles that have been verified in various research reviews. The investigation was undertaken in developing countries where, based on available literature and data, environmental problems are urgent. This study also involves 20 case samples and one stakeholder interviewed in a qualitative manner, persons who are experts in their fields (see Table 14). The data analysis method uses coupled within-case and cross-case methods to provide a complete description and conclusions that can be drawn from the findings of each sample cases. This results in the refined Circular Capability framework that integrates the NRBV and CE principles to overcome FLW.

The fourth follows the criteria “well done?”. The proposed proposition is built on the basis of observations of the latest, existing literature, but remains relevant to the research context. In addition, the proposition connects the theory of the NRBV and CE in the agri-food supply chain due to the similarity (gestalt) in terms of background, context, and solutions offered (see Table 7). To be able to find these various relationships, the author has observed intensively for a long time and reflected on the problems found in the factual conditions and the findings of the existing literature, thus, the author tries to build a proposition and is committed to verifying the propositions.

Fifth, “why now?”. As the FLW problem contributes significantly to the amount of methane gas in the atmosphere, leaving it unresolved would only escalate global warming, an already severe worldwide concern. In other words, this problem will be regarded more seriously as a global crisis in the future, as part of SDG 12.3. The urgency of global warming is emphasised during the recent COP26 summit, where nations gather to accelerate progress from the 2016 Paris Agreement and the UN Framework Convention on Climate Change, which set a target of rising global temperatures to 1.5 degrees Celsius. As such, this thesis will help reduce FLW in agri-food supply chains by identifying capabilities needed to implement a CE, which will prevent FLW from its source.

Sixth, “who cares?”. The findings of this thesis will be useful for both scholars and practitioners interested in the agri-food industry. In addition, the findings give insight for policy makers to provide necessary guidelines for the transition to a CE for the agri-food supply chain. This concept is based on the numerous benefits and favourable consequences for businesses that choose to understand the capabilities needed. The thesis' subject is also a topical issue that ought to be discussed by academics. This thesis is presented objectively with logical and clear reasons in order to assist academics and practitioners in meeting their individual needs, most notably in understanding the intricate details of the NRBV and CE principles in the agri-food supply chain. On the basis of the aforementioned, this thesis is deemed competent to provide an adequate theoretical contribution to the existing literature, in particular, NRBV theory, by exploring and creating building blocks of possible implications for other factors affecting this theory.

This thesis will also contribute to the government's efforts to take policies aimed at reducing the problem of FLW and its impacts. The government can use the results of this thesis as a reference in determining the right policy in the supply chain for each company, so government programmes can be made for farmers, distributors, and retailers on a wider scale and in a longer period of time. Furthermore, reducing the problem of FLW by implementing a CE in the agri-food supply chain can be a major breakthrough, especially in developing countries such as Indonesia, which is one of the countries with poor management of food loss and waste in the G20, in the same condition with Brazil, Mexico, Turkey, and Saudi Arabia (Economist Intelligence Unit 2021).This effort will certainly assist the government in improving people's welfare, maintaining price stabilisation, reducing poverty levels, and creating job opportunities, especially for companies and communities involved in the agri-food supply chain.

The thesis can also help NGOs to solve problems in the environmental field, especially FLW. This is due to the fact that the contribution of this thesis is in line with NGOs' operations on the basis of moral values, in which social cohesion capability is needed for manifestation of the principle of social responsibility. Thus, this thesis also suggests that companies involved in the agri-food supply chain can cooperate with NGOs in solving FLW problems, such as starting a food bank.

8.3 Limitations of the thesis and future research

This study identifies potential future research as the addition to the contribution, both for theory and practice. Although the thesis has limitations, as the nature of qualitative research may pose some question of generalisability, multiple case study was used to increase the validity that served as a limitation. To avoid bias, the participants are provided with the participant information sheet that informs them of their rights and briefly explains the purpose of the research. This thesis gathered the information mostly from a single informant, as the majority of the case samples was small-medium enterprises where it was more common in this context (Andersén, Jansson, and Ljungkvist 2020). Moreover, the participant involved was considered an expert with considerable knowledge in their field to be able to provide the insight and answer the questions on a topic (Meuser and Nagel 2009). The cases have provided sufficient data to answer the research question and objectives of the thesis. Given the limited time of the specified period of the study programme, the study design and number of selected cases are still considered appropriate. Future research could address limitations by using more cases, involving many respondents in each case, and extended stakeholders and complex research design can significantly improve the findings.

The study context may be expanded, reinforcing the need for future research in other settings. This thesis, in the Indonesian agri-food context, attempts to capture as comprehensive data as possible and use multiple case studies until it reaches data saturation. The variation of the size and different actors in the supply chain provides a comprehensive understanding on CE adoption, as this thesis provides sufficient detail in order to have the best picture of the real supply chain. Future research with a complex data set and different methods may possibly be conducted and advance this thesis, as well as involve other market structures such as other distributions channel. However, this thesis does not explore the perspective of the government that allows gaining insights and opportunities for future research-related policy development for a CE, which was addressed as a limitation of this thesis. Another research avenue beyond the scope of this research involves a large-scale survey to obtain customers' perspectives about the product specifications that need to be resolved. Such insight from customers is useful to help change the perspectives of perfect specifications that have long been in customers' minds. It is time for societal change to address environmental strain, which has begun to be heralded globally.

The proposition in this thesis is the output from a qualitative method, in which this thesis serves as the guide to conduct an opportunity for further research. A quantitative method using a survey to test the propositions can be established to obtain statistical generalisation. Under the critical realism philosophical stance, a mixed method can be conducted to measure the relationship between CE principles and the outcome, such as using structural equation modelling. It is worth noting that this thesis is unable to explore further to reveal the outcome of CE principles; this can be explained by the fact that observing a CE in practice is challenging due to participants’ limited knowledge of the term CE. Another factor is due to the structural market conditions that caused supply chain struggles with basic economic performance; hence, an important aspect related to the environment largely misses their attention. Accordingly, other CE outcomes are undisclosed apart from what this thesis identified in a qualitative manner; reducing food loss and waste, preserving natural resources, resilient economy, reducing green gas house emissions, and improving the local economy.

The systematic literature review may limit the results of the literature in using predefined keywords and the time when the papers were retrieved from databases. Some papers were added through cross-referencing. Future research may possibly improve the process used to conduct the SLR in this thesis, indicating that more papers may be missing, especially with rapid publications on the CE topic. More advanced processes and methods to establish a greater degree may provide a better version and address the limitations of this thesis, such as using VOS viewer for bibliometric networks for more extensive overviews of the literature.

Another theoretical lens that is possible to use in future research to investigate the CE is stakeholder theory to understand the stakeholder's role in depth, considering firms have different stakeholder environments. Furthermore, having conducted empirical research, it was found that there are dynamic relationships in the supply chains that are still in a silo, lack collaboration, and exhibit unequal power, especially at the upstream and midstream levels. This may raise asymmetric information and pose risks in creating FLW. Therefore, the firms may not experience the same performance gains. The combination of the NRBV and stakeholder theory to advance an understanding of the role of each of stakeholder in interconnected relationships between a business and its customers, suppliers, employees, and community in adopting CE aims to provide comprehensive view. Evidently, in the literature, the NRBV and stakeholder have been used to measure green practice and firm performance (Schmidt, Foerstl, and Schaltenbrand 2017). Transaction cost theory is also seen as a theoretical lens that can be used in CE research to understand the factors that may hinder CE adoption (Dossa et al. 2020). Life cycle analysis (LCA) can also be used to analyse environmental impacts along the supply chain further and use it as feedback to inform what capabilities are needed to overcome environmental impacts. Hart (1995) argued that LCA should be a legitimate strategy within firms as an internal planning tool to facilitate environmentally-friendly product development.

Sustainable development strategy in the NRBV that is still under-explored in the literature can also inform future research. This thesis, however, adds the contribution towards the importance of digital technology as an emerging theme as part of innovation in sustainable development and an avenue of social collaboration for involving the community, not just for alleviating poverty, but also for addressing environmental impacts. More research in the future could further expand on the thesis, as this thesis suggests the need to clarify the ambiguity of the original theory, and the importance of shifting the original theory that believes in the building of a new more affordable market for the growth of firms. This is because the original theory poses issues related to the ethics and exploitation of impoverished citizens for the advantage of large companies. As a result, changes should be made towards the direction of inclusiveness within the business and empowerment to, thereby, improve local welfare.

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APPENDICES

Appendix A

Interview guide

Introduction

- Please begin by telling me about your job role and what you are responsible for?
- What products do you grow/sell here?
- Who are these products supplied to? How long have you supplied these products?
- Further leading questions depending upon the role and remit

Pollution prevention

- Do you think there is pollution / waste in your context business?
- What is the cause? How much food loss or food waste? Are they recorded? Is there a certain season that cause an increase of food loss or waste?
- What about surplus/excess production? Does it cause food loss or food waste?
- How do you mitigate/prevent occurring waste?
- What do you do with the waste?

  Prompting further questions about this depending upon participant's knowledge of the problem

Product stewardship

- Please explain the process in the procurement of goods / raw materials?
- Have you ever had difficulty in obtaining raw materials? If so, how will you respond?
- Do you plan the product from the start, selection of material, until the end of the product?
- Do you know about Circular Economy?

  Prompting further questions about this depending upon participant's knowledge of Circular Economy
- Do you provide support or receive any guidance from suppliers and customers?
- How do you cooperate with your supplier / customer?
- Are you working with a university or other business entity to get involved in your business? (University, government, or organization) How?
- Do you conduct an assessment of what production input materials are used? (Seeds, fertilisers, chemical or organic)
- Do you use renewable materials?
- Do you must have any certifications?

Sustainable development

- What are the agricultural techniques/ equipment that you use today?
- What do you think about the technology that will advantage to your business?
- What is your company's plan to invest in more advanced technology?
- What is the social orientation of your company?
- Do you donate and have relationship with charities to distribute food?
- Is there any possibility for your company to create a new market for the lower consumer segment?

Closing questions

- What do you see as the main challenges related to the implementation of Circular Economy?
- Is there anything else that you want to add?

Appendix B

English Version

Participant No.

INFORMED CONSENT FORM:

Circular Economy Research and Development for Sustainable Supply Chain: A study of Farming Businesses in Indonesia

You are invited to take part in this research study for the purpose of collecting data on food waste. The project aims to strengthen the network of stakeholders throughout the Food Supply Chain (FSC) from farmers, distributors, market, consumers to waste managers in the FSC to collaborate to seek opportunities and implement innovate solutions to implement Circular Economy and ultimately reduce food loss and food waste.

Before you decide to take part, you must **read the accompanying Participant Information Sheet.**

Please do not hesitate to ask questions if anything is unclear or if you would like more information about any aspect of this research. It is important that you feel able to take the necessary time to decide whether or not you wish to take part.

If you are happy to participate, please confirm your consent by circling YES against each of the below statements and then signing and dating the form as participant.

1	**I confirm that I have read and understood the Participant Information Sheet for the above study and have had the opportunity to ask questions**	**YES**	**NO**
2	**I understand my participation is voluntary and that I am free to withdraw my data, without giving a reason, by contacting the lead researcher and the Research Support Office at any time until the date specified in the Participant Information Sheet**	**YES**	**NO**
3	**I have noted down my participant number (top left of this Consent Form) which may be required by the lead researcher if I wish to withdraw from the study**	**YES**	**NO**
4	**I understand that all the information I provide will be held securely and treated confidentially**	**YES**	**NO**
5	**I am happy for the information I provide to be used (anonymously) in academic papers and other formal research outputs**	**YES**	**NO**
6	**I am happy for the interview to be audio recorded**	**YES**	**NO**
7	**I agree to take part in the above study**	**YES**	**NO**

Thank you for your participation in this study. Your help is very much appreciated.

Participant's Name	**Date**	**Signature**
Researcher	**Date**	**Signature**
Niken Palupi Kusumo Wardani		

Appendix C

Table of initial proposition and refined proposition

Initial Proposition	Refined Proposition	Capabilities-CE principles	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
P1a	P2a	CI-WE	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P1b	P2c	CI-EO	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P1c	-	CI-EC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	P3c	SI-EC	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P2a		SI-MRV	**Y**	-	**Y**	-	**Y**	-	-	-	-	**Y**	-	-	-	-	-	**Y**	**Y**	**Y**	**Y**	**Y**
	P2b	CI-MRV	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P2b	P3b	SI-COEO	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P3		SV-LM	**Y**	-	**Y**	**Y**	-	-	**Y**	-	-	-	-	-	-	-	-	-	-	-	-	-
	P3d	SI-LM	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	P4a	SV-WEEO	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	P4b	SV-SR	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
P4		WE-FLW	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
		LM-PNR	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	-	-	-	-	-	-	-	-	-	-
		SR-LE	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	-	-	-	-	-
		SR-GHG	-	-	**Y**	-	-	-	-	-	**Y**	-	-	-	-	-	-	**Y**	**Y**	**Y**	-	-
P 5	P5	BR	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

(Y) = Verified
(-) = Unverified
CI-WE = Continuous Improvement – Waste Elimination
CI-EO = Continuous Improvement – Economic Optimisation
CI-EC = Continuous Improvement – Environmental Consciousness
SI-EC = Stakeholder Integration – Environmental Consciousness
SI-MRV = Stakeholder Integration – Maximisation Retained Value
CI-MRV = Continuous Improvement – Maximisation Retained Value
SI-COEO = Stakeholder Integration – Cascade Orientation Economic Optimisation
SV-LM = Shared Vision – Leakage Minimisation
SI-LM = Stakeholder Integration – Leakage Minimisation
SV-WEEO = Shared Vision – Waste Elimination Economic Optimisation
SV-SR = Shared Vision – Social Responsibility
WE-FLW = Waste Elimination – Reduce Food Loss Waste
LM-PNR = Leakage Minimisation – Preserved Natural Resource
SR-LE = Shared Vision – Local Economy
SR-GHG = Shared Vision – Reduce GHG
BR = Barriers

Appendix D

Case A

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination	Reduce FLW	**Internal Operation** *"Yes, first we do training, keep correcting what is going on with this, then maybe we are looking for facilities that can support this" (A-1).* *"The distribution is the most atrocious, we are finishing the products well with reusable packaging but then, for example, there is a sudden change of temperature, and as result vegetables continue become bruised or wet, such as in transpiration. When the customers receive them, the fruits and vegetables have changed physically, it can be their colour that has turn yellow-ish, or they are wet, and then they could be rejected" (A-1).* *"we have spent money on the packaging, labour and etc., but the rejection on the customer side is harmful" (A-1).* *"We not only think about the production, we will also think about preventing product not become waste; what would happen to the stock that has not been taken […] meanwhile we have plant every day. We make 100, 50 are asked for, that means there are already 50 surplus. Now, how we handle the other 50? […] the following days, the product will continue to be stocked for so one, two, three days have passed; meanwhile, for example, the commodity period has only one day left, so many vegetables have shrinkage because of that" (A-1).* *"we grow living things […] not always produce the same quality and weight as retailer wanted. For example, they require lettuce to be packed in 250 grams, but the crops more than 250 grams, then we peel it until 250 grams, the leftover leaves become waste. Sometimes our employee scrapped it too much; as a result, the lettuce below 250 grams, we cannot just add the leaf; therefore it becomes waste" (A-1).* *"We try to reduce vibrations during the distribution process that causes damaged or bruised leaves" (A-1).* *"I have no treatment, waste management, especially for the vegetables [...] but we want to process it to become something useful even though it is not always in the form of material" (A-1).* **Collaboration in the supply chain**
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Cut off system	Waste elimination		
		Improving facility	Waste elimination		
		Use superior seeds	Waste elimination		
		Proper handling	Waste elimination		
		Precision usage of pesticide	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
		Refrigerated truck delivery	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure	Leakage minimisation		
		Waste prevention	Waste elimination		
		Intensive supervising cultivation	Economic optimisation		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Understanding Agri-climate	Waste elimination		
		Internal training for better handling	Waste elimination		
	Culture	Implementing company value	Environmental consciousness		
		Strong commitment to reduce waste	Waste elimination Economic optimisation		
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		

		Communication with retailers	Economic optimisation	
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Comparative study abroad	Economic optimisation	
	Food safety compliance	Certifications Prima 3	Leakage minimisation	
	Using sustainable material	Using biodegradable plastic packaging for some product	Environmental consciousness	Preserved natural resources
		Re-usable crates	Environmental consciousness	
		Cardboard box	Environmental consciousness	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value	
		Processing food for value added products/derivative products	Cascades orientation Economic optimisation Maximisation of retained value	
		Re-package	Cascades orientation Economic optimisation Maximisation of retained value	
		Waste for animals feed and compost	Environmental consciousness Leakage minimisation	
Shared vision (Resource)	**Technology adoption**	Greenhouse	Waste elimination	
		NFT	Leakage minimisation	
		Drip irrigation	Leakage minimisation	
		Ozone filter	Leakage minimisation	
		Cold storage	Maximisation of retained value	
	Food processing	Wastewater treatment	Environmental consciousness	
	Future orientation to advance technology	Indoor system with automatic temperature control	Environmental consciousness	
	Digital technology	Online shopping	Economic optimisation	

"consumers nowadays are very critical about the traceability of all the products" (A-1).

"Some consumers want to know where the fruits and vegetables come from and even do a small research on the product before they buy it" (A-1)

"We use a brand that makes it easy to trace, especially for end-users; they can easily find the information from the Internet" (A-1).

"Maybe, one thing we have done is substitute rockwool with peat moss, which is more environmentally friendly" (A-1).

. "Electrical energy, maybe especially for biomass" (A-1)

"Yes, we are already [using recyclable plastic], so if previously it was not easy to decompose or break down, now the plastic can immediately be decomposed" (A-1).

"In Thailand, they already use some materials from bananas for packaging, but it seems like it has not yet been applied in Indonesia. There's no banana farmer that lets their banana leaves be processed as packaging" (A-1).

Technology Adoption

"the NFT system is easier to manage and calculate the speed of turn over faster turn over. If it is said to be easy, it means it is easier to manage; each of the commodities has their own characteristics in cultivation" (A-1).

Social Orientation

"Now we have not yet headed there yet but there are people who take it for maggots. So, they ask us for the waste for free. Yes, we allow it, but it is not under our management system, it's other people using it" (A-1).

Barrier

"For people, probably the easiest way is to make compost from it, but to wait for it to be decomposed, there are many treatments that need to be done" (A-1).

	Social cohesion	Community involvement in the business (Food donation to employee, safari park and community)	Social responsibility	Local economy	

Barriers	Category
Do not know about CE concept	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Uncertainty in price	Supply chain
Unmarketable surplus production	Supply chain
Lack of support from other chains	Supply chain
Long supply chain in another channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
Technical problem with sustainable packaging	Technology
No model for CE	Lack of government support

Case B

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Continuous Production plan	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"not all seeds will be suitable to be planted in our area because each place has its characteristics […] and we need to understand that" (B-1).* *"We face difficulties during the dry season. We have to make reservoirs in tanks during the rainy season for irrigation purposes [...] we ask support from other growers" (B-1).* *"Yes, but if during the dry season, if there is waste around here, the waste can be used for livestock, breeders, and freshwater fish. Maybe there are ducks, there are goats […] If it is not suitable for consumption, we leave it in the fields or for compost" (B-1).* *"Yes, we usually rely on manure for organic fertiliser. We are very different from the rice fields, as rice fields rarely use fertiliser, but if we are in the highlands in the horticulture area, yes, it is imperative to use fertiliser […] because if we use only chemical fertilisers, it's probably the microelements that are different" (B-1).* **Collaboration in supply chain** *"First, about cropping patterns, anticipating the weather, then our needs, then there might be new technological innovations, or there might be new seeds because the seeds are not always in good condition in the long term. So, maybe from the seed producers from 2-3 years, at the most 5 years later, then we will need to find another source of superior seed." Regarding seedling input, case B get from their network "we attempt to make seeds, but the rest we have to get from Lembang" (B-1).* *"they don't give much input to that area" (B-1)* *"I think we can recycle it, but it is in the modern retailers' hands" (B-1).* **Barrier in adopting Circular Economy** *"We have tried to communicate but sometimes it is not easy, maybe because we small and do not have power" (B-1).* *"If they told us to do so, we will follow their request, as long as the cost is realistic" (B-1).*
		Delivery scheduling and stacking arrangement	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Use superior seeds	Waste elimination		
		Internal innovation for better handling	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
		Refrigerated truck for delivery	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure	Leakage minimisation		
		Intensive supervising cultivation from NGO	Economic optimisation		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Understanding agro climate	Waste elimination		
		Training for proper handling	Waste elimination		
		Strong commitment to reduce waste	Waste elimination Economic optimisation		
Stakeholder integration (Resource)	**Interorganisational Cooperation**	Communicating with suppliers about raw material stock	Waste elimination		
		Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular meeting with grower members	Economic optimisation		
		Regular visit from distributor/retail	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		

	High order learning	Strong relationship with government in grower organization	Economic optimisation		*"The weather, maybe like yesterday's wind, the wind made the plants fall, they fell down" (B-1)* *"Yes, we really are, how independent we are […] growers can be taught to make the seeds, how about the cultivation technology? Maybe with efficiency tools, then how about the market readiness? Well, often what we are a little strange about is the growers' limitations for market information. Because market information is very important, on the other hand, the commodities planted by the growers are planted here, planted there, they're planted, but they are not connected, how many they produce, what may be local needs, how many nationally you don't know. The data doesn't match, it doesn't accurate because the data taken is usually from extension workers" (B-1)*
		Learning from other network and association	Economic optimisation		
		Support from university for soil test	Economic optimisation		
		Transfer of technology and knowledge from international NGO	Economic optimisation		
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation		
	Food safety compliance	Certifications Prima 3	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserved natural resources	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
Shared visions (Resource)	**Digital technology**	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business (Food donation to employee and community)	Social responsibility	Local economy	
		Growers welfare	Social responsibility		

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial

Do not have waste handler	Lack awareness to environment
Volatile price	Supply chain
Over production in certain season	Supply chain
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Reluctance to change	Culture

Case C

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"I have to restore the soil that has been really damaged by chemicals; it takes a really long time – about two years. So, you can imagine how long I did not get income [...] just had to invest in the soil. Then I found guano that has a high content of nitrogen, phosphate and potassium [...] key nutrients for plants" (C-1).* *"We know what we are planting what are suitable to our farm, and what minerals are inside, otherwise we just wasting our resources" (C-1).* *"I spray using red onion, coconut water, mineral water in one glass of mineral water; I blend, I squeeze it, so maybe it can fit into one bottle of mineral water […] keep spraying it, and it will crush the kausim" (C-1).* *"Sometimes it is beyond predictions, like yesterday, it was rainy season, high rainfall. The carrots were just washed away" (C-1).* *"At the time we plant, pick fruit, we throw away rather we rejected […] Once it starts to bear fruit, we know that instead of throwing it away waiting until ripe, nutrients are there, so it wasted a lot" (C-1).*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Identify potential waste with Cut off system	Waste elimination		
		Use superior seeds	Waste elimination		
		Proper handling	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Minimum usage of chemical pesticide	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure	Leakage minimisation		

		Intensive supervising cultivation	Economic optimisation	
	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience in hospitality	Economic optimisation	
		Understanding agriculture climate adaptation	Waste elimination	
		Training for proper handling	Waste elimination	
	Culture	Implementing owner value	Environmental consciousness	
		Strong commitment to produce high quality produce	Waste elimination Economic optimisation	
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination	
	Informaton sharing	Demand data sharing	Economic optimisation	
		Regular visit from customer	Economic optimisation	
		Communication with retailers	Economic optimisation	
		Intense communication with customers for high quality product in niche market	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other chain such restaurant/hotel about demand	Economic optimisation	
		Support from university for innovation	Economic optimisation	
		Comparative study abroad	Economic optimisation	
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserve natural resources
		Cardboard box	Environmental consciousness	
	Product development	Collaboration with a nutrition expert	Economic optimisation	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value	
		Processing food for value added products/derivative products	Cascades orientation Economic optimisation Maximisation of retained value	

"the law of attraction […] to be honest, I don't want to talk about waste, the more I talk about waste, the more it will come" (C-1).

"so, if I think about reject, it will break my concept, I don't want to ruin my foundation, because, ok that's alright, there will be rejection, it is fine, finally the negative thoughts will resonate and my product will finally reject and we cannot enter the market" (C-1).

"We go towards developing a personalised size of fruits. One family, usually they have a maximum of two children, right? Then, for example, if they buy watermelon up to five kilos, they cut it, the leftover is stored in the fridge, but they often feel it is not fresh any longer; finally, the leftover is given to their domestic helper or even discarded" (C-1)

Collaboration in supply chain

"I learn by myself, get information, learn how to produce high quality products. I was rejected 13 times with the same modern market, is hard my product to enter to that store. Finally, my product was accepted, for me it was the real certification. I don't know such sophisticated terms" (C-1).

"I introduce them and try to educate them by showing that the products are not only affordable, but also good for health" (C-1).

Barrier in adopting Circular Economy

"They have their own patterns" (C-1).

		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
Shared vision	**Technology adoption**	Drip irrigation	Leakage minimisation		
	Food processing	Technology for food processing	Maximisation of retained value		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business (food donation to employee and community)	Social responsibility	Local economy	
		Helping young generations grower welfare	Social responsibility		
		Charities and support reforestation	Social responsibility		

Barriers	**Category**
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
Burnt waste	Lack awareness to environment
Volatile price	Supply chain
Over supply	Supply chain
Lack of supply of raw material from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Reluctance to change	Culture

Case D

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"We implement an integrated farming system already, so actually, this is from the local genius of the founding fathers […] if you want to do farming you have to have animal husbandry, the leftover vegetables are used for their feed, from them we get the manure for fertiliser [...] as well as we make organic pesticides, If we can make it ourselves then we don't have to buy it" (D-1).* *"We implement permaculture, and we synchronise all activities so as not to harm the environment" (D-1).* *"Not organic, is unavoidable using chemicals, […] it is so hard not to use any chemical substance [...] but within the terminology of Integrated Pest Management, so growers will understand that the treatments they will apply are used properly, according to the safe dosage, without leaving an unusual high residue" (D-1).* *"[…] because not all the quality and qualifications of agricultural products enter the modern market, it means that we are also targeting other market segments such as restaurants, including traditional markets. So, there will be classifications of products" (D-1).* *"Yes, for example, if we send the products to Jakarta, we send it to the distribution centre, so they open up at 2 am to receive goods; this means we will harvest today from 10 am to 2 pm. Then we process the sorting, grading, and packaging; at 10 pm we send it out, and two hours later arrives at Jakarta" (D-1)* **Collaboration in the supply chain** *"It is a consideration from the start that the soil analysis is important to be conducted, so we can determine how much chemical content is needed for the soil […] we are also assisted by them from the cultivation and technology for agriculture by PUM from the Netherlands and JICA from Japan, we receive a lot of transfer of knowledge from them" (D-1)* *"Until now we do not have any certification either Prima 1 or 2 or Sucofindo" (D-1).* *"In fact, those NGOs is from the customer network, from the market side, they trust more in their network, right?" (D-1).* *"Well, we communicate with modern retailers, about what kind of trends are currently happening. That is the time to chat with local parties*
		Delivery scheduling	Maximisation of retained value		
		Integrated farming to collaborate supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Improving facility	Waste elimination		
		Use superior seeds	Waste elimination		
		Minimise handling process	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
		Permaculture	Leakage minimisation		
		Cold chain management	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure refer to GAP	Leakage minimisation		
		Intensive supervising cultivation for member grower	Economic optimisation		
	Learning process	Understanding product and cultivation activity	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Adaptation to any weather condition	Waste elimination		
		Training for proper handling	Waste elimination		
	Culture	Implementing spiritual values	Environmental consciousness		
		Strong commitment to produce high quality produce	Waste elimination Economic optimisation		
		Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular meeting with grower members	Economic optimisation		
		Regular visit	Economic optimisation		
		Communication with retailers	Economic optimisation		
		Intense communication with customers and suppliers for	Economic optimisation		

		product development and new variant		
		Communicating with seed and fertiliser suppliers	Waste elimination	
	High order learning	Strong relationship with government	Economic optimisation	
		Learning from other network and association	Economic optimisation	
		Support from university, central Bank for innovation	Economic optimisation	
		Comparative study abroad	Economic optimisation	
		Transfer of technology and knowledge from international NGO	Economic optimisation	
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation	
	Food safety compliance	Certifications (GAP, Prima, organic, ISO, halal), audit internal and external	Leakage minimisation	
	Using sustainable material	Using recyclable plastic packaging	Environmental consciousness	Preserved natural resources
		Re-usable crates	Environmental consciousness	
		Cardboard box	Environmental consciousness	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value	
		Waste for animals feed	Environmental consciousness Leakage minimisation	
		Waste for compost	Environmental consciousness Leakage minimisation	
Shared vision (Resource)	**Technology adoption**	Greenhouse	Waste elimination	
		NFT	Leakage minimisation	
		Drip irrigation	Leakage minimisation	
		Cold storage	Maximisation of retained value	
	Waste processing	Wastewater treatment	Environmental consciousness	
	Digital technology	Wireless irrigation system	Leakage minimisation	

because we also have good connections with people in the Netherlands, and with people in Japan" (D-1).

"Still, still (we still use plastic)" (D-1)

"Yes, that was because we collaborated with modern retailers, accompanied by JICA. The direction is like this […], the direction is like this, yes we follow but give the solution too" (D-1).

"We are collaborating with several BUMNs, such as PT KAI, then with PT Bahana, because this BUMN has a PKBL programme; it's like a Community Development Partnership Programme. So BUMN distributes partnership programmes to our fostered growers, to increase production capacity, for capital for the farmers" (D-1)

"[…] for technology, it is the infrastructure that we received through CSR support from Bank Indonesia […] to be able to increase production capacity" (D-1).

Social orientation

"For those who enter the supermarket, it means they're being prepared to go to the supermarket, the product that does not meet specifications means they're being prepared for the traditional markets" (D-1)

Barrier in adopting Circular Economy

"To get agricultural production following market demand, well actually for administrative matters like that it should be the government who helps us, it should not be us filling in things like that" (D-1).

"If we talk about the supply chain, […] the length of the supply chain, that's the problem, so from farmers to collectors, collectors to dealers, wholesale markets, wholesale markets to small markets, small markets to vegetable traders, vegetable traders to consumers; this is a very long supply chain that creates a high level of damage to the vegetables" (D-1).

"We have calculated how much chilli is needed in Indonesia, but many restaurants are closed, so that becomes over-production; that's one of the conditions" (D-1).

		Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business (Food donation to employee and community)	Social responsibility	Local economy	
		Growers welfare	Social responsibility		

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
Volatile price	Supply chain
Over supply	Supply chain
Un synchronize between chain	Supply chain
Shor term contract	Supply chain
Long supply chain in other channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Need strong leadership to move beyond CE	Culture

Case E

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"Our produce is divided into two categories: A and B [...] It is combined into one grade export. Below that range will be sold in domestic [modern and traditional] markets" (E-1).* *"small fruits [...] we process further for crisps, assortment, toffee" (E-1).*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		

	Operational process	Use superior seeds	Waste elimination		**Collaboration in supply chain** *"we have a group system. So, there are groups called cattle rancher. Animal dung will be processed in compost house to fermented. After fermented then it will be distributed to the farmers in accordance to their groups" (E-1).* **Barrier in adopting Circular Economy** *"once we had the experience to donate to the boarding school, it has about 6 thousand students, per student, it already has 3 kilos. Even when I tried to give them still got rejected, because is too much, eventually had to be thrown away" (E-1).* *"It fluctuated due the market dynamics in this competitive industry, there is a saturation point, we must expand the market to export" (E-1).* *"I don't know what CE is […] but if you mean integrated, I think we had implemented that" (E-1).* *"[…] we need support from the government for distribution of salacca to other islands because Indonesia is an archipelago country which is not neatly organised and they need to start to think about processing fruits in large scale" (E-1).*
		Maintaining product temperature	Waste elimination		
		Non-chemical pesticide	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Reducing lead time of delivery	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure	Leakage minimisation		
		Intensive supervising in packaging process	Economic optimisation		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from new market (export)	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Understanding climate	Waste elimination		
		Training for proper handling	Waste elimination		
	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation		
Stakeholder integration (Resource)	**Interorganisational Cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular meeting with grower members	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
		Communicating with suppliers	Waste elimination		
	Learning	Strong relationship with government	Economic optimisation		
		Learning from other network and join exhibition	Economic optimisation		
		Comparative study abroad	Economic optimisation		
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation		
	Food safety compliance	Packing house and organic certification	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserve natural resources	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		

		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Conveyor sorting machine	Waste elimination		
	Waste processing	Chopper	Environmental consciousness		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Donation to orphanage	Social responsibility	Local economy	

Barriers	**Category**
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment in changing material	Financial
Burnt waste	Lack awareness to environment
Price unstable	Supply chain
Over supply during peak seasons	Supply chain
Lack of support from other chains	Supply chain
Group grower dynamic activities	Supply chain
Long supply chain in other channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Reluctance to change	Culture

Case F

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning and rotation	Waste elimination	Reduce FLW	**Internal operations in waste prevention** *"Well, now we use lots of crates. So, the post-harvest process has begun to improve. There were lots of sacks in the past […] now we use plastic crates" (F-1).* *"Back then, we use used plastic bags, but now we have used plastic crates" (F-1).* *"People here does not want that knowledge of tracking or recording like foreigners […] There is none. People never calculate that" (F-1).* *"Whether it has to be surmounted or not, it depends on the farmer where they sell their product. Whether it can be sold almost 100% immediately, those discarded crops will be fertiliser" (F-1).* **Collaboration in supply chain** *"Currently, the cooperation with the Batu City Agricultural Service is excellent. They encourage us to use organic manure fertilisers. The local government distributed organic fertilisers to the growers. So here, the land fertility is preserved" (F-1).* *" Guidance, training, workshops, exhibitions are also provided by the government to growers, not individuals, so that these legal growers group can also enjoy all the programs from the Ministry of Agriculture to the Agricultural Service" (F-1).* *"We have cows ranches that we manage, and we use the dung for fertiliser and biogas. Recently, we collaborate with PT Pegadaian to manage waste" (F-1).* *"Sometimes the application that is still low for growers. But the government also uses rules. We finally know how to manage plastics. There is a place, and there are facilitators from Pegadaian [pawnshop], there are facilitators from the government. So, there are parties who manage the waste in Batu City" (F-1).* *"We are assisted with the cultivation method, our cultivation we form a collaboration with PKPHT Brawijaya University, lecturers who carry out dedication program, continue to foster growers based on technology development, continue to be supported by the institutional strengthening of various parties. Finally, there is a success" (F-1).*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil protection with pro bactery	Leakage minimisation		
	Operational process	Use superior seeds	Waste elimination		
		Proper handling	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
		Cold chain management	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure refer to GAP	Leakage minimisation		
		Pest control			
		Intensive supervising cultivation	Economic optimisation		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Anticipating climate	Waste elimination		
		Training for proper handling	Waste elimination		
	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation		
Stakeholder integration (Resource)	**Interorganisational cooperation**				
		Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular meeting with grower members	Economic optimisation		
		Regular visit	Economic optimisation		
		Communication with retailers	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
		Communicating with suppliers	Waste elimination		
	Learning	Learning from other network and association	Economic optimisation		

		Strong relationship with government	Economic optimisation		*"we must be open about technology and information, keep updated with regulation, with our current team that's working right now, we hope that our product outcome will have a certain quality in here and overseas" (F-1).* *"We must be technology literate, information literate and regulatory updates" (F-1).* **Technology adoption** *"The most advanced agriculture in Indonesia is Batu City, to prepare a soil people here not using tractor anymore but excavator. Some use greenhouse and rain shelter, the one that's more impressive the use of a drone for pesticides, some also implement demonstration plot besides mulch" (F-1)* *"Cold storage, for grading, there are members who have used machines, such as apples. Just a simple machine" (F-1).* *"Some have used hand tractors, and it is technology. Suppose the excavator is only growers who have vast land and one stretch. Well, they use an excavator, which is only for soil management. They also have tools for making holes in plastic mulch, not manual again" (F-1).* *"Apart from the knowledge we got from other parties, we also conduct comparative studies to other regions to upgrading knowledge. If you get knowledge, you can apply it more efficiently, you will use it here" (F-1). Some growers now replace the bamboo with the stake, "for plant stakes, these stakes used to use bamboo only, now use takiron stakes that can be re-use. But because of the fear of growers, the stake will be stolen, well, it is only some of the growers who use from the factory-made stake" (F-1).* **Barrier in adopting Circular Economy** *"If sustainable activity in agriculture is just like this. Yesterday I immediately asked the intern who are apprenticed there. In theory, it is considered really decent. There, around Gresik, it has land, then the fertiliser is said to be from the chicken and goat livestock. There are some that have fisheries, and then it is planted there, then finally they are also making outlets there, used for sales. However, they suffered a loss. Theory, for theory, for learning such as recreation areas, that is all, agricultural education" (F-1).* *"Yes, we do want this group to be sustainable, we do have hope but to handle the human resource is difficult" (F-1).*
		Support from university for innovation	Economic optimisation		
		Comparative study abroad	Economic optimisation		
		Transfer of technology and knowledge from international NGO	Economic optimisation		
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation		
	Food safety compliance	Certifications Prima 3	Leakage minimisation		
		Audit internal and external	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserved natural resources	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		
		Processing food for value added products/derivative products	Cascades orientation Economic optimisation Maximisation of retained value		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
		Collaboration with state owned company in waste management	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Greenhouse	Waste elimination		
		Drip irrigation	Leakage minimisation		
		Drone for pesticide application	Leakage minimisation		
		Sprinkle	Leakage minimisation		
		Heavy equipment for managing soil	Leakage minimisation		
		Cold storage	Maximisation of retained value		
	Food processing	Technology for food processing	Maximisation of retained value		
	Digital technology	Smart apps for grower	Economic optimisation		
		Wireless irrigation system	Leakage minimisation		

	Social cohesion	Community involvement in the business (Food donation to employee and community)	Social responsibility	Local economy	
		Growers welfare	Social responsibility		
		Charities and global green hospital	Social responsibility		

Barriers	**Category**
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
Burnt waste	Lack awareness to environment
Volatile price	Supply chain
Over supply	Supply chain
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Reluctance to change	Culture

Case G

Pollution Prevention Strategic capabilities	**Operational Capabilities**	**Actions**	**CE Principles**	**Outcome**	**Responses**
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"The loss still happens because of shrinkage, technical problem, and some of the exception. We hit by the pandemic that made us lose in economic, and we had to dispose of around three tonnes of lettuce" (G-1).*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		

		Hydroponic media	Leakage minimisation	
	Operational process	Use superior seeds	Waste elimination	
		Proper handling	Waste elimination	
		Non-chemical pesticide	Leakage minimisation	
		Appropriate harvest time	Leakage minimisation	
		Accurate handling	Maximisation of retained value	
	Control	Applying standard operating cultivation procedure	Leakage minimisation	
		Intensive supervising cultivation	Economic optimisation	
	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience	Economic optimisation	
		Understanding weather conditions	Waste elimination	
		Training for proper handling	Waste elimination	
	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation	
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular visit	Economic optimisation	
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation	
		Communicating one supplier	Waste elimination	
	High order learning	Learning from other grower	Economic optimisation	
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserved natural resources
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value	

"For seeds, we used imported because we are committed to quality. Imported seeds adaptable compared to the local seeds" (G-1).

"Because definitely there is waste there, but if there is loss one, it's only 10%. So, from 5000 seeds, only around 4500 will grow, but there must be, on average" (G-1).

"The treatment is more likely about checking for nutrients. First of all, nutrient. Second, the acidity of water or PH" (G-1).

"Actually even though we set up many blowers the temperature will still be high. The function is more like to decrease the temperature of the room" (G-1).

"If it gets too hot, then the vegetables will be withered. It is not dead but more likely to get withered" (G-1).

"We do have something named business review to evaluate our performance and set up the next plan. We updated the contract with our customers. It is not only about renewal, but we do price updates and negotiation, or for example, we want to reduce the quantity or add new variety. We do it every three months… we do not want to sell to traditional markets because we do not face price wars with conventional farmers" (G-1).

"No need [cooler] because if it is around here except if we send it out of town" (G-1)

"Automatically, we will use the refrigerated truck that has chiller in it" (G-1).

"The problem here is we do not have [livestock], so as a solution, we use the waste for fertiliser, but sometimes we only pile them up. They will end up burned down" (G-1).

"We do not use any pesticides" (G-1).

Collaboration in supply chain
"We interact directly every day, we search purchasing department then we ask their kitchen section, who is responsible for it. However, we usually deal with the head with the kitchen department or the chef" (G-1).

"For example, in lettuce they need certain wide of the leaf or etc. If it is not fit with their request, then we can get penalty. For example, if we failed one plant then we will give them two in return, or we replace it with the value of money" (G-1).

"So, we can read the graphic, demand from who, how about people in kitchen department. Every day we interact with them. We also update regarding selling and market trend, in terms of business market. Second, in terms of market

					demand it usually invisible we really have to update frequently, market research, we are strolling around in the market and ask people there" (G-1). *"Many of us also survey directly to the field, learn from the growers" (G-1)* *"Definitely. We are included as the consumer who buys the most amongst the other" (G-1).* *"Firstly, we are researching that for the first time we ever bought the seeds from the importer. We did research in anticipation for example the seeds supply is hampered, we actually have three kinds of imported seed: Bejo and RZ from Netherland while Jhony seed is from America. If it's hard then we don't have another choice but to use local seeds. These local seeds we observe in sense that we still obtain the specification that we wanted" (G-1).* *"Our seeds importer also produce the fertiliser even though not commercialised because they only cooperate with partners, they also sell the rockwool. So those three items we get from one supplier it already cut down the operating cost" (G-1).* **Technology adoption** *"Resource that we feel most important is electricity […] The electricity is efficient because we only use one pump" (G-1).* *"Yes, we made a well specifically for it. The water will be circulated underground then it will come back, we do have pipes that is pointed out back to the reservoir, before get there, there is small pond that's the function is for filtering so when the water return to the reservoir clean, if we want to filtering water it is on that pond" (G-1).* *"Last April we intent to create landscape, something like garden landscape, we will try organic also it will add the aesthetic. Maybe it will start from there, and later we will make decomposer, a place to make compost" (G-1).* *"Yes, if there is technology that might help us, maybe solar panels, maybe in the future it will be the most needed in the future Yes because yes in Indonesia, this is a monopoly of PLN" (G-1).* *"Yes, because we do not have any agriculture background, so we need to stay updated. There are no special resources" (G-1).*
Shared vision (Resource)	**Technology adoption**	Greenhouse	Waste elimination		
		NFT	Leakage minimisation		
	Waste processing	Wastewater treatment	Environmental consciousness		
	Future orientation to advance technology	Photovoltaic	Environmental consciousness		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement (Free hydroponic training)	Social responsibility	Local economy	

Barriers	Category
Minim information about CE	Knowledge
Perfect product specifications	Structural

High investment advancing technology	Financial
Burnt waste	Lack awareness to environment
Volatile price	Supply chain
Low demand	Supply chain
Lack of support from other chains	Supply chain
Uncertainty supply of imported seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Reluctance to change	Culture

Case H

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"So definitely, it called off grade, we have on grade, we have shrinkage products. We have BS reject. So if it's off grade; it looks good, the length is good, there aren't all kinds of insects and all, but it is basically long over than it should be" (H-1).* *"Some of them being taken and used as cow feed. For example, peel mustard and cabbage. But actually, it still be used even when it is backfilled, which the growers does not realise that it is actually become organic, becoming the next cycle of fertiliser" (H-1).* *"We intend to plant one ton, the yield one ton and a half, yes, then we sell it to the modern market. Finally, we have a volume there, increasing in population, in management, increase in control" (H-1)* *"So for example, if we want to increase production by only 10%, it means that the area must increase, meaning that one cycle must increase. If for example, the first cycle is well, before the broad limitations, limited control,*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Use superior seeds	Waste elimination		
		Proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean process	Maximisation of retained value		
		Cold chain management	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure refer to indo GAP	Leakage minimisation		
		Intensive supervising cultivation	Economic optimisation		

	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience	Economic optimisation	
		Understanding agro climate	Waste elimination	
		Training for proper handling	Waste elimination	
	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation	
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular meeting with grower members	Economic optimisation	
		Communication with retailers	Economic optimisation	
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Strong relationship with government	Economic optimisation	
		Support from university for innovation	Economic optimisation	
		Comparative study abroad	Economic optimisation	
		Transfer of Capital and knowledge from central Bank	Economic optimisation	
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserve natural resources
		Cardboard box	Environmental consciousness	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value	
		Waste for animals feed	Environmental consciousness Leakage minimisation	
		Waste for compost	Environmental consciousness Leakage minimisation	
		Greenhouse	Waste elimination	

limited mobility. All of that must be reviewed. Agribusiness is complex" (H-1).

Collaboration in supply chain

"From the CSR of modern retail, we got assisted to make electricity from biogas. When the cabbage is harvested, the remaining leaves are eaten by the cow, the cow's dung enters into the biogas canister, then the biogas on the stove becomes electricity and provided light for the packing house. That is their hope but was inefficient, and growers do not understand" (H-1).

"Yes, until now, Unpad has supported us in many ways. Oh, from the farming management, new variety plant, packing house management" (H-1)

"we are included in Bank Indonesia Cluster to be part supporting inflation control, we received tractors, cold storage and rain shelter" (H-1).

"Yes, that is a legitimate demand. Requirements. That means our packaging must be made of plastic. The mayor stated yesterday that styrofoam could not be used. Then, when we use the tray as reusable crates, the cost per pay increases" (H-1)

"So far, plastic just burned. To be honest, we have been in that situation, where we move to food-grade packaging. However, if the feedback is unbalanced, what is the point? Even so, what is the ultimate reward for us? If the requirement must be made, then we must comply. I think back there, communication between us and the market, with the government, with friends who really want to cooperate with us" (H-1).

Barrier in adopting Circular Economy

"This is cattle, and this is the farm, then the manure for farming. It was done decades ago. So it should be more in the direction as a whole system. Oh, I planted, how many days will be sold, buy by whom, at what price, with what payment. This packing house as a logistics function, oh, with the market as a market cooperation partner, oh, with the bank as the supply chain finance. Now, it's call integrated. People from Japan have come here. They tell us a lot about Japan and so on. I said We do not need that standard. What we need are production and price. Indonesian growers need that" (H-1).

Shared vision (Resource)	**Technology adoption**	Drip irrigation	Leakage minimisation		
		Sprinkle	Leakage minimisation		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business	Social responsibility	Local economy	
		Food Donation	Social responsibility		

Barriers	**Category**
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
Burnt waste	Lack awareness to environment
Volatile price	Supply chain
Over supply	Supply chain
Group dynamic	Supply chain
Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Lack of communication from government about CE concept	Lack of government support
Reluctance to change	Culture

Case I

Pollution Prevention Strategic capabilities	**Operational Capabilities**	**Actions**	**CE Principles**	**Outcome**	**Responses**
Continuous improvement (Resource)	**Planning**	Production planning based on choosing the right variety	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"There is no soil rejuvenation here, in fact there the usage of land is unstoppable every season, so we use compost as the alternative and try not being excessive in term of chemical dosage, as the result our soil is always fertile" (I-2)*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Choosing quality seeds	Waste elimination		
		Proper handling	Waste elimination		

		Applying integrated pest management	Leakage minimisation	
		Appropriate harvest time	Leakage minimisation	
		Efficient lean process	Maximisation of retained value	
		Refrigerated delivery truck	Maximisation of retained value	
	Control	Applying standard operating cultivation procedure refer indo GAP	Leakage minimisation	
		Intensive supervising cultivation	Economic optimisation	
	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience	Economic optimisation	
		Anticipating weather change	Waste elimination	
		Training for proper handling	Waste elimination	
	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation	
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular meeting with grower members	Economic optimisation	
		Intense communication with customers not only for retail but also for food manufacturing	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Strong relationship with government	Economic optimisation	
		Support from university for innovation	Economic optimisation	
		Join for central agro market foundation		
		Comparative study abroad	Economic optimisation	
		Transfer of technology and knowledge from international NGO	Economic optimisation	
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserved natural resources

"Because we are as growers, what else do we want? No more ideas. Meanwhile at the meantime we don't own any adequate tool to process it. So, yes, we give it people, use it as feed, or compost" (I-2)

Collaboration in supply chain

"The pesticide manufacturer come visit the farm. Teach the application of pesticide, introduce the variety, communicate the problem, the finding solution. They teach safety, use PPE, gloves. Because the first exposure is not a problem, not the nose or eyes, but the skin"(I-2)

"The government must be brave enough to do mapping of the region or for example, production center. Production center for the needs of each market, for example, this market needs 100 tons, the centre is from anywhere per day, right? There is no certainty in us, even though sometimes the government told that there is a shortage of supply. Well, but when growers nearly harvest time, for example, chili, when we nearly want to harvest a lot, how come there is sudden import chilli? Change of land function also needs to be addressed that threatening food security." (I-1)

"Yes, cardboard, plastic, and styrofoam, we just follow the customer's request. I know it causes the environmental problem, but we have no choice. Recently, one of the state-owned banks has an idea to help waste processing, but this still at the concept stage"(I-1)

Social orientation

"I am referring to 50 hectares, if 50 hectares I am ready to produce Baby French for at least 2 tons per day, it's possible at a minimum. 50 growers have a workforce of 5 people, and the workforce is also apparent, 250 people are absorbed." (I-1)

"Yes, it is clear that the market continues, the market wants a price contract here because it is welfare if it is supported by adequate land"(I-1)

"How many the rejects are, we will take responsibility for them, if growers send to us 100 kilos, then we count it as 100 kilos." (I-1)

"Why such paradigm appear because here [this industry] there is no market clarity. The market does exist, but price uncertainty makes products sometimes marketable, sometimes not. So, low interest and they do not want to take the risk." (I-1)

Barrier in adopting Circular Economy

"The difference between pesticide systemic and contact is that if the contact is indeed a fast process, the growers are happy to use the fastest one.

	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		*That's why there are many products that contact, actually it's not a bad product, but often growers make a wrong application." (I-1)* *"We have tried technology for automatic irrigation. So, yes, because it was just testing, the system still needs to be repaired, automatically as a grower they do not believe that this tool can save water. It can increase productivity. So the main obstacle is if growers are aware of technology, where are the results? is it good? They want prove to convince growers. If it's not good, it's hard, you can't enter." (I-1)* *"Yes, think for yourself, for example, we have buyers because we search them by ourselves. Buyers, for example, we contract and build cooperation with exporters. But there is no involvement of the government." (I-1)* *"So, many people talked about integration concept, but only a concept, they not assisting. But again, the problem is market access. Sometimes many people give the concept of integration, but growers are enough to give the concept, there is no assistance to get market access after they cultivate it, that the most needed." (I-1)*
		Integrated with cattle farm	Cascades orientation		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Greenhouse	Waste elimination		
		Drip irrigation	Leakage minimisation		
		Gondola for transport	Leakage minimisation		
		Sprinkle	Leakage minimisation		
	Digital technology	Smart apps for grower	Economic optimisation		
		Computerized irrigation system	Leakage minimisation		
	Social cohesion	Community involvement in the business	Social responsibility	Local economy	
		Combining green tourism	Social responsibility		
		Corporate social responsibilities (Global green hospital)	Social responsibility		

Barriers	**Category**
Lack of understanding of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
Business risks	Financial
High investment advancing technology	Financial
Burnt waste	Lack awareness to environment
Volatile price	Supply chain
Over supply	Supply chain
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain

Uncertainty supply of seeds	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support
Reluctance to change	Culture

Case J

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Production planning based on demand	Waste elimination		**Internal operation in waste prevention** "*Here, something that is not resolved is the packaging problem, the hydroponic is packaged with plastic where it cannot be 100% recycled" (J-1).* *"We started it already by giving a certain level of customers, we change the packaging to the reusable one, recycled packaging in Indonesia is expensive" (J-1).* *"Yes, included the defect, the level of tolerance, like it's impossible to be perfect like if during receiving there is one leaf broken or the leaf is become yellow-ish it still can be accepted" (J-1).* *"it has already started, but lacks in promotion and publication are lacking" (J-1).* *"It is about a mismatch between supply and demand at first. We will break down the problems. The incompatibility of both quality and quantity could be the reason for waste. As in quality, it might be good, but the handling process during delivery is not appropriate, and then it's about the delivery time as well" (J-1).* *"Each division we will hold a training according to their functional for example packer, how to packer properly" (J-1).*
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
		Soil management	Leakage minimisation		
	Operational process	Improving facility	Waste elimination		
		Use superior seeds	Waste elimination		
		Proper handling	Waste elimination		
		Applying integrated pest management	Leakage minimisation		
		Appropriate harvest time	Leakage minimisation		
		Lean coordination	Maximisation of retained value		
		Refrigerated truck delivery	Maximisation of retained value		
	Control	Applying standard operating cultivation procedure refer to GAP, HACCP, Prima	Leakage minimisation		
		Waste prevention	Waste elimination		
		Intensive supervising cultivation	Economic optimisation		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Understanding climate change	Waste elimination		
		Training for proper handling	Waste elimination		

	Culture	Strong commitment to reduce waste	Waste elimination Economic optimisation		*"Yes, It is the policy first because if you don't make SOPs [standard operating procedure] or you don't make work instructions and policies, the implementation will be confusing" (J-1)* **Collaboration in supply chain** *"Yes, so far we have communicated with several breeders, for example, we have five or types of plants that we will market, now we draw them into a production plan, right from the production plan the on-farm needs has resulted" (J-1).* *"For example, we committed there should be seeds in December, but due to crop failure of mid-production we did not get the seeds, in the end, we will try to fulfil with local production" (J-1).* *"For example, they test, multi-site tests, for example, they want to introduce certain varieties to Indonesia, there are requirements from the department, it happens that our location is one of the sites, they usually propose to test the location" (J-1).* *"They have their agendas for each region, they will ask them, we included, for example how we produce cherry tomato and we want to see the market's response toward it, we often ask about that, but specifically for research we have not done that" (J-1).* **Barrier in adopting Circular Economy** *"The plastic, it can't be recycled we still not find the replacement" (J-1).* *"The customers are not ready to change their mindset. They are used to perceived products should in the perfect specification, not the misshaped one" (J-1).* *"It's hard to synchronise the interest. We have tried several times, for example, we gave vegetable waste to fertiliser companies to process it into COC, but the collaboration did not work out" (J-1).* *"There should be more practices on a smaller scale, the government should create collaboration not only in big scale" (J-1)*
Stakeholder integration (Resource)	**Interorganisational cooperation**				
		Demo plot with seed, fertiliser and pesticide suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		
		Communication with retailers	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
		Communicating with suppliers	Waste elimination		
	High order learning	Learning from other network and association	Economic optimisation		
		Comparative study abroad	Economic optimisation		
		Technical support from manufacturer (seed, pesticide and fertiliser)	Economic optimisation		
	Food safety compliance	Certifications HACCP and Prima	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserve natural resources	
		Cardboard box	Environmental consciousness		
	Product development	Arrange internal research and development	Economic optimisation		
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		
		Re-package	Cascades orientation Economic optimisation Maximisation of retained value		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
		Waste for compost	Environmental consciousness Leakage minimisation		
Shared vision (resource)	**Technology adoption**	Conveyor sorting machine	Waste elimination		
		Wrapping machine	Waste elimination		
		Cold storage	Maximisation of retained value		

	Future orientation to advance technology	Automatic packer	Economic optimisation		
	Digital technology	Website for social media	Economic optimisation		
	Social cohesion	Community involvement in the business (Food donation to employee and community)	Social responsibility	Local economy	

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
No facilities	Structural
High investment advance technology	Financial
High cost for upgrading packaging	Financial
Volatile price	Supply chain
Over supply	Supply chain
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain
Mismatch between supply and demand data	Supply chain
Low improvement in farming technology	Technology
No model for CE	Lack of government support
Unclear regulation	Lack of government support

Case K

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (Resource)	**Planning**	Order management	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"…our SOP [standard operating procedure], we want no stock. So, growers have to send daily and because we send daily to modern retailers to keep freshness." (K-1)*
		Product specifications book	Waste elimination		
		Delivery scheduling	Maximisation of retained value		

		Accurate forecasting supply and demand	Economic optimisation	
	Operational process	Applying FIFO system	Waste elimination	
		Zero stock policy	Waste elimination	
		Improving facility	Waste elimination	
		Use superior seeds	Waste elimination	
		Proper handling	Waste elimination	
		Lean process	Maximisation of retained value	
		Representative Warehouse	Maximisation of retained value	
		Cold chain management	Maximisation of retained value	
	Control	Waste prevention	Waste elimination	
		Field service team to support sales	Economic optimisation	
		Production team supervising cultivation	Economic optimisation	
	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience	Economic optimisation	
		Regular training for proper handling	Waste elimination	
	Culture	Strong commitment to reduce waste	Waste elimination	
Stakeholder integration (Resource)	**Interorganisational cooperation**	Partnership with growers/suppliers	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular visit	Economic optimisation	
		Communication with retailers	Economic optimisation	
		Intense communication with retail for innovative product	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Support from university for innovation	Economic optimisation	
		Comparative study abroad	Economic optimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	Preserved natural resources
		Cardboard box	Environmental consciousness	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation	

Collaboration in the supply chain

"It means we have to educate our suppliers, our growers, to send their crops according to the stage and specifications we want. We encourage them to apply good practice, and they increase their productivity and have the opportunity to enter modern markets through us, which is better for them than traditional markets. If growers understand how everything needs to be treated, there will be a little waste." (K-1).

"The competitive advantage of our company is that we always think that consumers [modern retailers] are not tired of the innovation of developing trade models; however, consumers sometimes do not want to bother because of the many choices available. They want vegetable products as well as fast food products that can be taken home immediately." (K-3).

"What we can do is, we can only change conventional plastic into plastic that is easy to recycle. However, reducing the packaging depends on the retailers. Some care, some do not. If they ask us to change, we certainly do that." (K-1).

Barrier in adopting Circular Economy

"Because sometimes it's also for the sake of art, so that it looks more artistic, it's thrown away. Deliberately thrown away. It's deliberately wasted, even though it is edible." (K-1).

"Suppose we want a good pokcoy. Well, it will cause waste, because when there is a pokcoy that is a hole, it is rejected. Even though it turns out that the smooth Pokcoy was sprayed with pesticides, for example, the caterpillars were sprayed. So, our perspective is also influenced by the perfect specifications. For retailers, they just follow the customer, yes, he is already on display, there are no holes at all. The next day they did not want to receive the pokcoy leaves with holes in them." (K-1).

"Public awareness must also support this industry; this industry is growing because we value our own products. Moreover, this is one of those influences that affect to our thoughts on the product itself." (K-1).

			Maximisation of retained value		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Small conveyor sorting machine	Waste elimination		
		Wrapping machine	Waste elimination		
		Cold storage	Maximisation of retained value		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business	Social responsibility	Local economy	
		Donation for employee	Social responsibility		

Barriers	Category
Mis information about CE	Knowledge
Perfect product specifications	Structural
Land contour	Structural
Remote locations	Structural
High investment advancing technology	Financial
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain
Technical problem with sustainable packaging	Technology

Case L

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Weekly Order	Waste elimination		**Internal operation in waste prevention** *"we have grower as partners, we assisted them, providing seeds, fertiliser and technical farming to ensure that the plant is grow like what retailers want" (L-1).* *"Although I have collaborated and have a partnership with growers, I still have to face the risk of having crop failure" (L-1).*
		Product specifications with brix test	Waste elimination		
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		

		Improving facility	Waste elimination		**Collaboration in supply chain** *"Retailers have an independent audit team, so later we will have a term for example, when planting melons, what kind of pesticide should be monitored, the insecticide level, chemical content, soil residue, what fertilisers were used" (L-1).* **Technology adoption** *"for melons we have to be intense, intense almost every 2 days, we have to monitor. We have a group chat. I don't have to go to location, later from the grower, the report is like this. Like today's report, today's date is at 2:42 p.m. already reported, the progress, what will we do later if there are problems usually, they photographed, sir, how about this disease, like that. We solved the problems together." (L-1)*
		Proper handling when receiving	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Minimum lean process	Maximisation of retained value		
	Control	Intensive supervising cultivation	Economic optimisation		
		Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
	Culture	Strong commitment to reduce waste	Waste elimination		
Stakeholder integration (Resource)	**Interorganisational cooperation**	Demo plot with seeds suppliers	Waste elimination		
		Expand partnership with growers from other province	Waste elimination		
	Information sharing	Demand data sharing from grower partner	Economic optimisation		
		Regular visit from retail	Economic optimisation		
		Communication with retailers	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
	High order learning	Learning from other network and association	Economic optimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness		
		Cardboard box	Environmental consciousness		
	Food waste mitigation	Distribute below specifications products to traditional market	Cascades orientation Economic optimisation Maximisation of retained value		
		Using waste as organic fertiliser	Leakage minimisation		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
Shared vision	**Technology adoption**	Conveyor sorting machine	Waste elimination		
		Wrapping machine	Waste elimination		
	Digital technology	Social media for communicating and supervision	Economic optimisation		
	Social cohesion	Community involvement for young farmer	Social responsibility		
		Growers welfare	Social responsibility		

Barriers	Category
No information about CE	Knowledge
High grade product specifications	Structural
Soil damage	Structural
Remote locations	Structural
Business risks	Financial
High investment but low sales price	Financial
Lack of support from other chains	Supply chain
Grower group dynamic	Supply chain
Long supply chain in other channel	Supply chain

Case M

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Weekly order from retail	Waste elimination		**Internal operation in waste prevention** *"That is why we coordinate the growers; whether I like it or not, I have to do selection; I just want to accept something like this because retailers require specifications like this" (M-1).* *"We teach them [growers] that way. If you do not want this to happen, use this fertiliser in along with this method" (M-1).* *"There is one, something like that in modern retailer. But for middle and low economic class. Because it is their second market, usually because the product is purchase in large quantity. So there are potatoes that just misshaped like that" (M-1).* *"Yes, there are some food waste caused by handling process. Fruits and vegetables are perishable product and very susceptible, if they're being handled poorly they will end up damaged. But it is not a lot. We have long experience, we learn" (M-1).*
		Product specifications book	Waste elimination		
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving facility	Waste elimination		
		Proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Lean process	Maximisation of retained value		
		Priority in delivery	Maximisation of retained value		
	Control	Intensive supervising cultivation	Economic optimisation		
		Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated year of experience	Economic optimisation		
		Training for proper handling	Waste elimination		

<table>
<tr><td></td><td>Culture</td><td>Strong commitment to reduce waste</td><td>Waste elimination</td><td></td><td rowspan="19">"It will be monitored later. It must be the customers that complaint, they often take a photo of it and send out to us after that they told them to make sure it will not happen again" (M-1).
"It will be monitored later. It must be the customers that complaint, they often take a photo of it and send out to us after that they told them to make sure it will not happen again" (M-1).

Collaboration in supply chain

" In this case, the buyer or modern retailer, besides set specifications for the products, wants to know where we get our products and our ability to meet their needs. They also control the way it is packaged and determined weight in one package. Maybe eggplant is packaged in 300 grams in Hero or another modern retailer, Lotte they want 500 grams. We follow their specs. Every modern retailer has their specifications" (M-1).

"It diverse, leaf vegetables, it depends on the customers' demand, many things have to manage, we need to keep up to date" (M-1).

"Once per year we contract. For more specific, the price is being updated once per week alongside the purchase order Sometimes, there is some revision midst of the distribution process, mostly about additional product" (M-1).

"I know. But we use styrofoam. It has environmental impact but my duty is just follow their want. They are the one that have rules" (M-1).

Technology adoption

"It is really needed, but for export there is my packing house, I collaborate with my friends in Jakarta, they already use machine. Use cold storge, conveyor, cleaning machine. Now, not everything has to be with machine. So have do manual. To clean off it can't be done with machine but maybe someday I will invest" (M-1).</td></tr>
<tr><td rowspan="12">Stakeholder integration (Resource)</td><td>Interorganisational cooperation</td><td>Partnership with growers/suppliers</td><td>Waste elimination</td><td></td></tr>
<tr><td rowspan="5">Information sharing</td><td>Demand data sharing</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Regular visit to grower</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Communication with retailers</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Intense communication with customers and suppliers for product development and new variant</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Communicating with suppliers</td><td>Waste elimination</td><td></td></tr>
<tr><td rowspan="2">High order learning</td><td>Learning from other network and association</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Comparative study abroad</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Food safety compliance</td><td>Audit internal and external</td><td>Leakage minimisation</td><td></td></tr>
<tr><td>Using sustainable material</td><td>Re-usable crates</td><td>Environmental consciousness</td><td></td></tr>
<tr><td rowspan="2">Food waste mitigation</td><td>Distribute below specifications products to traditional market</td><td>Cascades orientation
Economic optimisation
Maximisation of retained value</td><td></td></tr>
<tr><td>Waste for animals feed</td><td>Environmental consciousness Leakage minimisation</td><td></td></tr>
<tr><td rowspan="6">Shared vision (Resource)</td><td rowspan="3">Technology adoption</td><td>Mini cold storage</td><td>Maximisation of retained value</td><td></td></tr>
<tr><td>Conveyor sorting machine</td><td>Waste elimination</td><td></td></tr>
<tr><td>Wrapping machine</td><td>Waste elimination</td><td></td></tr>
<tr><td>Digital technology</td><td>Using websites, apps, and social media for marketing</td><td>Economic optimisation</td><td></td></tr>
<tr><td rowspan="2">Social cohesion</td><td>Community involvement in the business (Food donation to employee and community for surplus stock)</td><td>Social responsibility</td><td></td></tr>
<tr><td>Motivator for Growers welfare</td><td>Social responsibility</td><td></td></tr>
</table>

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
High investment advancing technology	Financial

Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain

Case N

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Order management	Waste elimination		**Collaboration in supply chain** *"Yes continuity also quality, regarding quality it depends on the seasons, the most important thing that during the hard season the result is not that bad"(N-1).* *"we receive PO [purchase order] before day one or day two we prepared, then we communicate to the growers During the dry season, there is no rainfall at all, but we do have some rainfed land. Then production begins to decline"(N-1).* *"Not only during the dry season, but also during the rainy season, when rainfall occurs during the day and night, it affects how crops grow, but many of them also decay" (N-1).* *"We mostly do it in retail, we go there not alone, there might be competing with others, there must be other suppliers in the retail. They are already there, they may have new items that are in high demand in the retail, so our development in terms of a commodity is increasing" (N-1).* *"like from the vocational high school or universities they have their fields, there are cultivation, post-harvest, they can learn what we are doing. We exchanged knowledge" (N-1)*
		Product specifications book	Waste elimination		
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving facility and equipment for employee	Waste elimination		
		Proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Efficiency during lean process	Maximisation of retained value		
		Refrigerated truck delivery	Maximisation of retained value		
	Control	Intensive supervising cultivation	Economic optimisation		
		Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from NGO supervision	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
	Culture	Strong commitment to reduce waste	Waste elimination		
Stakeholder integration (Resource)	**Interorganisational cooperation**	Partnership with growers/suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		
		Communication with retailers	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		

		Communicating with suppliers	Waste elimination		
	High order learning	Learning from other network and association	Economic optimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness		
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation Maximisation of retained value		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value		
		Conveyor sorting machine	Waste elimination		
		Wrapping machine	Waste elimination		
		Treatment plasma ozon	Leakage minimisation		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business	Social responsibility		
		Growers' welfare	Social responsibility		

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
High investment advancing technology	Financial
Lack of support from other chains	Supply chain
Group dynamic	Supply chain
Long supply chain in other channel	Supply chain

Case O

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
	Planning	Order management	Waste elimination		**Internal operation in waste prevention**
		Product specifications book	Waste elimination		

Continuous improvement (resource)		Delivery scheduling	Maximisation of retained value	
		Forecasting supply and demand	Economic optimisation	
	Operational process	Applying FIFO system	Waste elimination	
		Inventory management	Waste elimination	
		Improving facility	Waste elimination	
		Proper handling	Waste elimination	
		Minimum buffer stock	Waste elimination	
		Lean process	Maximisation of retained value	
		Cold chain distribution	Maximisation of retained value	
	Control	Intensive supervising cultivation for partner	Economic optimisation	
		Waste prevention	Waste elimination	
	Learning process	Understanding product knowledge	Economic optimisation	
		Learning from stakeholder	Economic optimisation	
		Accumulated experience	Economic optimisation	
		Training for proper handling	Waste elimination	
	Culture	Strong commitment to reduce waste	Waste elimination	
Stakeholder integration (Resource)	**Interorganisational cooperation**			
		Partnership with growers/suppliers	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular visit	Economic optimisation	
		Communication with retailers	Economic optimisation	
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Support from university for innovation	Economic optimisation	
		Comparative study abroad	Economic optimisation	
	Food safety compliance	Standard HACCP, ISO 22000, SSOP, GMP and Halal certificate	Leakage minimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	
		Cardboard box	Environmental consciousness	
	Food waste mitigation	Distribute below specifications products to other channels	Cascades orientation Economic optimisation	

"After we received a purchase order, we then make an MoU following that we communicate to our partner. For regular customers, we know what they want, so we provide based on their order" (O-1).

"There are some that we gave to the community nearby to be processed to be composted. There are some that fish farmer collects" (O-1)

Collaboration in supply chain

"products from our partner farm is 70-80%, the rest we buy it from the market. We do have partners, supervision, there's continually visit, auditor visit the growers and give counselling if there's some items that we can't grow by ourselves, we should import […] the key is trusted, partner" (O-1).

"Several times we do some test, micro test every month, E-coli, Listeria, Salmonella, then later we will test pesticide residues, once a year there is also a water test that we use" (O-1).

"We're really active, for example, if a consumer has a global standard so internationally, they have a standard too, for example, product specification, so we follow that" (O-1).

"That's from the product side. For research, we send supply, diced potatoes, if we do not use sodium, it will be easier to turn brown, so we don't use it" (O-1).

"Everywhere our team always have reviewed, I learn from the owner. To be a pioneer is not easy. Back then, our leader collaborated with a company from the Netherlands. From that collaboration, I learn. They suggest how to cut vegetables properly, what machinery should be use" (O-1).

"We got a chance to work with a company from the Netherlands as a sister company, a joint venture then we develop our product by selling not only vegetables but also meat, it becomes bigger and bigger" (O-1).

"We collaborate with online service providers in selling our products, for example with Blibli, Go fresh, Shopee some are sent to consumers directly, some are to their distribution centre, they help us make profiling the target market, how many of them close order, how many are not. It is useful for us" (O-1).

Technology adoption

"About technology, we don't have any choice but to follow our customers with a global brand that direct us to use the machine and procedures. We usually have some session with customer with the international

			Maximisation of retained value		*standard then they will share to us. For example, cleaning machine, ozone filter. But technology does not only use the machine, because if talking about HACCP the procedure needs to be like a system from upstream to downstream, facilities and human resources" (O-1)* *"For temperature, we must create it with air conditioner, we use blower then rinse it, for packing room is 10 degree, to maintain the freshness of the vegetables we have another option but to use the air conditioner" (O-1).* **Barrier in adopting Circular Economy** *"Logically, it could be adopted here, but the problem is that there's still much waste that none want to pick up, before we have collaborated with a zoo, they took it, but we gave it for free" (O-1).* *"There should be new invention such as the chopper machine for waste. So it can process a compost, then we also need people who have ideas and technology" (O-1).* *"There is waste every day, and it is not that bad, it is only getting trimmed, it will be better if there's people who want to accommodate it then chop it. I told the students in university several times to create chopper machine or making compost, we will give it [waste] for free, but the determination is low, many also the bachelor of agriculture not working on this field" (O-1).* *"We don't have the technology" (O-1)*
		Form in vegetable pack ready to cook	Cascades orientation		
		Waste for animals feed	Environmental consciousness Leakage minimisation		
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value		
		Washing and cutting machine	Waste elimination		
		Wrapping machine	Waste elimination		
		Ozone filter	Leakage minimisation		
	Waste processing	Wastewater treatment	Environmental consciousness		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Community involvement in the business	Social responsibility		
		Growers welfare	Social responsibility		

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Lack of support from other chains	Supply chain
Long supply chain in other channel	Supply chain
Unavailable sustainable packaging in large scale	Supply chain

Technical problem with sustainable packaging	Technology

Case P

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Sending order weekly for supplier and daily delivery	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"we have the KPI for breakage items cannot exceed from 0.6% from sales." (P-2)* *"All our losses are recorded in the system we use and are overseen by many people."(P-2)* *"We are training the team. In fact, we have a quality and hygiene team that independently monitors its work methodology, product handling, food handling, and even the display implementation rules are monitored by internal and external quality hygiene."(P-1)* *"the action we take is to do an in-depth analysis, why there are so many losses. Is it wrong in the number of orders or wrong handling in the display or because of poor storage?" (P-3)* *"If we do not make this […], for example, this one is half broken. We make salad from the good half." (P-2)* *"Juice, salad, juice. Or we make food here. But it is only from the good ones, the bad ones we still discard"(P-2)* *"we open the skin into sliced fruit, make banana cake, banana juice."(P-1)* *"Excess orders without looking properly at average sales will cause large food losses or breakages."(P-3)* *"Food waste is a sensitive issue. Our company is concerned about the food safety issue and the continuity of the business. dealing with food waste […] We chop up the products, even using chemical to make sure anyone cannot use it." (P-1)* **Collaboration in supply chain** *"It's regulated because we have an internal and external hygiene audit" (P-3)*
		Receiving product based on specifications book	Waste elimination		
		Receiving time scheduling priority	Maximisation of retained value		
		Accurate forecasting supply and demand	Economic optimisation		
	Operational process	Priority for leaf vegetables according FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving facility in receiving or distribution centre	Waste elimination		
		Quality control to assure proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Minimise lean process	Maximisation of retained value		
		Cold chain storage	Maximisation of retained value		
	Control	Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
		Training for quality control	Waste elimination		
	Culture	Implementing company value	Environmental consciousness		
		Strong commitment to reduce waste	Waste elimination		
Stakeholder integration (Resource)	**Interorganisational cooperation**	Commitment with many suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		
		Intense communication with customers and suppliers for	Economic optimisation		

<table>
<tr><td rowspan="8"></td><td></td><td>product development and new variant</td><td></td><td></td><td rowspan="15">"we have SOPs on this. If indeed the product has to be refrigerated, then it must be sent using a cooler, if the product is indeed at room temperature, then there is no need to send it by using a refrigerated truck. Depending on the type of products sent." (P-3)

"Two sides. It could be from us; it could be from the supplier. Even the idea from the supplier is good, and even the supplier is rich with innovation. Such as, the factory for the innovation of packaging, bottles, all kinds. Sometimes our customers sometimes said, too big, then we can change them to smaller or something. We have a sales development name. There is a sales development. Sales Development aside from looking for new ideas, they also make innovations that suit to customers. So, two sides. So sometimes the sales manager also does a survey to customers asking them what you want?" (P-3)

Technology adoption

"So far the technology is currently quite efficient. We use a showcase chiller. But, investment in advanced technology depends on company policy" (P-3)

Social orientation

"No, because later if the person is sick, they will ask where the food come from; it prevents things like that. Although some food is still edible." (P-1)
"We have been working with a third party to distribute food waste, but because they misuse it, we no longer trust them; so we have stopped that programme." (P-1)

Barrier in adopting Circular Economy

"Whether it can be possible or not. In my opinion, it is not easy. Our consumers want the perfect product but at low prices, unlike in the West country where they really care about Earth. Extraordinary, but it will not take a short time to implement it; it may take ten years maybe." (P-2)

"Not yet, because we have not been able to get the substitute for it. That's the problem." (P-1)

"Once again, we are commercial, and we count everything. The products we buy we count, even the taxes we pay to the government, actually bear the customers. Packaging is following the function of the product, and for example, the product must use a cup, dry products we used to use styrofoam. But now we are starting to turn to food-grade paper bags or mica plastic. Because not all of them cannot be replaced, now it's like a bamboo box, right? No one can provide thousands even if we use leaves. Who can provide the whole of Indonesia? We follow some things, but the flow is according to the function of the product."(P-1)</td></tr>
<tr><td>High order learning</td><td>Learning from headquarter and retail association</td><td>Economic optimisation</td><td></td></tr>
<tr><td rowspan="2">Food safety compliance</td><td>Government supervision</td><td>Leakage minimisation</td><td></td></tr>
<tr><td>Audit internal and external</td><td>Leakage minimisation</td><td></td></tr>
<tr><td>Using sustainable material</td><td>Re-usable crates</td><td>Environmental consciousness</td><td></td></tr>
<tr><td rowspan="3">Food waste mitigation</td><td>Processing food for value added products/derivative products</td><td>Cascades orientation
Economic optimisation
Maximisation of retained value</td><td></td></tr>
<tr><td>Re-package</td><td>Cascades orientation
Economic optimisation
Maximisation of retained value</td><td></td></tr>
<tr><td>Promotion and discount price one hour before store closed</td><td>Cascades orientation
Economic optimisation
Maximisation of retained value</td><td></td></tr>
<tr><td rowspan="7">Shared vision (Resource)</td><td rowspan="4">Technology adoption</td><td>Cold storage</td><td>Maximisation of retained value</td><td></td></tr>
<tr><td>Showcase chiller</td><td>Maximisation of retained value</td><td></td></tr>
<tr><td>Using LED light to save energy</td><td>Environmental consciousness</td><td></td></tr>
<tr><td>Automatic sprayer</td><td>Maximisation of retained value</td><td></td></tr>
<tr><td>Food processing</td><td>Technology for food processing</td><td>Maximisation of retained value</td><td></td></tr>
<tr><td>Digital technology</td><td>Using website and online shopping</td><td>Economic optimisation</td><td></td></tr>
<tr><td>Social cohesion</td><td>Corporate social responsibilities; Earth hour</td><td>Social responsibility</td><td></td></tr>
</table>

					"Even earlier, some were selling cheaply, we really don't recommend it. It could be a staff buying. Because those who buy employees first, maybe only 20% of the customers, but they deliberately produce more, so the price is more like buy one get one free at 9 pm. So, there will be a question, how come the sales that buy one get one free are a lot more than the regular ones? That is not good for business." (P-1)

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Business risks	Financial
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Poor practise land filling	Lack awareness to environment
Unavailable sustainable packaging in large scale	Supply chain

Case Q

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Purchase order management	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"Usually it is about the handling issue if the handling-loading is not done properly or the display is arranged carelessly these can be the reasons why products are damaged" (Q-1).* *"Perhaps when they are in the storage, being arranged, they are allowed to collide with each other so there are a lot of blisters. It depends on the FIFO. If it works, then less waste" (Q-1).* *"When consumers select products, they tend to ruffle them. Some put them back in a proper arrangement, but others do not. So, they become damaged. So there is our staff who rearrange the products every hour. So sometimes the things get messy, there must be someone around to sort them" (Q-1).* *"It is not all items. Maybe it is only bananas, sweet potatoes, onions that can be returned to our suppliers. The rest are not returnable" (Q-1).*
		Product specifications book	Waste elimination		
		Receiving scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Daily inventory management	Waste elimination		
		Improving facility	Waste elimination		
		Quality control proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Efficiency lean process	Maximisation of retained value		
		Cold chain management	Maximisation of retained value		
	Control	Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		

		Learning from stakeholder	Economic optimisation	
		Training for proper handling	Waste elimination	
		Training for quality control	Waste elimination	
	Culture	Implementing company value	Environmental consciousness	
		Strong commitment to reduce waste	Waste elimination	
	Information sharing	Demand data sharing	Economic optimisation	
		Regular visit	Economic optimisation	
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation	
		Communicating with suppliers	Waste elimination	
	High order learning	Learning from other network and association	Economic optimisation	
		Audit internal and external	Leakage minimisation	
	Using sustainable material	Re-usable crates	Environmental consciousness	
	Food waste mitigation	Processing food for value added products/derivative products	Cascades orientation Economic optimisation Maximisation of retained value	
		Re-package	Cascades orientation Economic optimisation Maximisation of retained value	
		Promotion and discount one hour before store closed	Cascades orientation Economic optimisation Maximisation of retained value	
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value	
		Showcase chiller	Maximisation of retained value	
		Automatic sprayer	Maximisation of retained value	
	Food processing	Technology for food processing	Maximisation of retained value	
	Future orientation to advance technology	Photovoltaic	Environmental consciousness	
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation	
	Social cohesion	Corporate social responsibilities (Earth hour, reforestration)	Social responsibility	

Collaboration in supply chain

"Every month they will come to visit and discuss several important factors regarding business activity, and there is also product training and QC training, hygiene quality learning, classes for upgrading handling skills" (Q-1).

"Most of our crop contract are on fruits. Most of them are able to supply their product continuously" (Q-1).

"The meeting is in the HO, but sometimes suppliers invite us; it is similar to a study tour. it is a crucial way to improve the performance of both parties" (Q-1).

"Mainly the inspection is about expiring products, food security and hygiene." (Q-1).

Social orientation

"Before we had a programme with local people, who suggested the waste can be used as animal feed. It was running but eventually had to be stopped" (Q-1).

"In addition to product training, there is also QC training, learning on the quality of hygiene, classes for upgrading, increasing salaries, there are special classes, so they are taught calculating formulas. There is also social awareness training which is practised at home affairs to form personal and responsible. Suppose the environmental problem is more to the upper people. Later the top people will train us. Some are indifferent, but people who want to listen to will find this training useful" (Q-1).

Barrier in adopting Circular Economy

"In some modern retailers, there are many derivative products, but here we are limited making such products, only for fruits" (Q-1)

"We try to look at the alternative, such as plastics from corn-based, but I whether the material is available or not, I don't know yet, is not easy, if we use paper for the packaging it will be easily be ripped off" (Q-1).

"Yes, it will be destroyed immediately. In fact, there was once such discourse from employees about why the company does not donate it to a charity or even sell it to employees at half the price, but in the end, this was not implemented" (Q-1).

Barriers	Category
Lack of knowledge of CE	Knowledge
Perfect product specifications	Structural
Business risks	Financial
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Poor practise land filling	Lack awareness to environment
Unavailable sustainable packaging in large scale	Supply chain

Case R

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Weekly order management	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"products that is edible but no longer worth displaying" (R-1).* *"Even with small friction or being piled up, they are very fragile, so there is an immediate potential for damage" (R-1)* *"From there, they enter the display area, after which they're put on display; there's also sorting here. The sorter is the customer. The products that the customer does not take are most likely to be damaged" (R-1).* *"Is about 5 per cent. It comes from the total amount of damaged products every month that we have calculated. This includes due to consumer behaviours, for instance when they try some fruit to only then eat half of it and put the rest back on display" (R-1).* *"So those restaurants [...] They do not buy the product elsewhere; they buy it from us" (R-1).* *"Yes, we have complete training for our employees. For new employees, we give them product knowledge and handling training" (R-1).*
		Product specifications book	Waste elimination		
		Receive scheduling and prioritize for vegetables	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving stacking facility	Waste elimination		
		Quality control proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Lean process	Maximisation of retained value		
		Cold storage	Maximisation of retained value		
	Control	Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
		Training for quality control	Waste elimination		

	Culture	Implementing company value	Environmental consciousness		**Collaboration in supply chain** *"First of all, it is their continuity" (R-1).* *"Yes, for specifications, we have the agreement rules" (R-1).* *"Yes, one of them is a work programme. For a year, it has been running. If we talk about vendors, I think it will be about product development. We communicate about the sales, trend, and payment system… So this company provides great opportunities for its suppliers to compete… What do they have. Come on, make a programme. So we give flexibility to the suppliers if they want to make product development, such as ready to eat package" (R-1).* **Barrier in adopting Circular Economy** *"We are not using direct natural resources, but what we sell are products from natural resources" (R-1).* *"Our people used to the perfect product specifications. We adjust to being like them. This is the good standard, and then, in the end, all modern retail has the same mindset; that a good product is flawless, big, straight, basically it has to be perfect. However, this brings problems for growers. If we buy all grades, it will be cheaper, but then we have an obstacle because we have to follow specifications book" (R-1).*
		Strong commitment to reduce waste	Waste elimination		
Stakeholder integration (Resource)	**Interorganisational cooperation**	Contract with many suppliers	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit to distributor	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
	High order learning	Learning from headquarter and retail association	Economic optimisation		
	Food safety compliance	Audit internal and external	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness		
	Food waste mitigation	Processing food for value added products/derivative products	Cascades orientation Economic optimisation Maximisation of retained value		
		Re-package	Cascades orientation Economic optimisation Maximisation of retained value		
		Promotion 50 % discount for downgrade vegetables	Cascades orientation Economic optimisation Maximisation of retained value		
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value		
		Showcase chiller	Maximisation of retained value		
		Automatic sprayer to keep fresh	Maximisation of retained value		
	Food processing	Technology for food processing	Maximisation of retained value		
	Digital technology	Online shopping websites, apps, and social media	Economic optimisation		
	Social cohesion	Corporate social responsibilities follow headquarter regulation	Social responsibility		

Barriers	Category
Lack of knowledge of CE	Knowledge

Perfect product specifications	Structural
Business risks	
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Poor practise land filling	Lack awareness to environment
Unavailable sustainable packaging in large scale	Supply chain

Case S

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	**Planning**	Order management and contract buyer	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"those types of vegetables that probably we can still utilise, they are stages, we make one step before final disposal […] they can be made into a salad or become pickles. Yet, it must also be sold in the same day, cannot be more than that, same as the fruits have some steps before they completely become waste" (S-1).* **Collaboration in supply chain** *"For us, surely it is continuity; secondly, quality. The price will follow the quality. The quality is important because we need to compete with other retailers" (S-1).* *"we work together with the supplier, exchange ideas how to innovate the product, like the current trend healthy lifestyle, we talked with suppliers how we can serve our consumers" (S-1).* *"For now, we never had it [contract farming]. What we have ever done before is a crop pattern contract. For example, the vendor has a group of growers. So, next, there will be tomatoes for 5 or 10 tonnes. Then we negotiate with them about the price and specification with a contract, ok I will take 5 tonnes like that. I think it's only like that" (S-1).* *"For scaling the product that we sold in bulk, it has to use plastic. If not, then there will is the possibility of misuse from customers if they bring their plastic bags from home, such as how they will put the products into them" (S-1)*
		Product specifications book	Waste elimination		
		Delivery scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving facility	Waste elimination		
		Proper handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Lean process	Maximisation of retained value		
		Cold chain management	Maximisation of retained value		
	Control	Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
		Training for quality control	Waste elimination		
	Culture	Implementing company value	Environmental consciousness		
		Strong commitment to reduce waste	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		

		Communicating with many suppliers	Waste elimination		*"Inside the packaging, we no longer use styrofoam. We already use mica, so it is already more environmentally friendly…other retailers may still use it [styrofoam]" (S-1)* *"In the future, I have thoughts about the leafy vegetables, for example, they could be wrapped with banana leaf instead of sticky tape, but we need to look into the banana leaf availability" (S-1).* **Social orientation** *"I do not know if it is in the store. But I'm worried it will be done wrongly by some parties. So, if there is a damaged product, we just destroy it all" (S-1).* **Barrier to adopting Circular Economy** *"There are usually two grades that we accept, A and B" (S-1).* *"Yes, it is a must [the specification] because every retailer has its strength"(S-1).*
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
	High order learning	Learning from other network and association	Economic optimisation		
	Food security	ISO certification and Halal	Leakage minimisation		
		Audit internal and external	Leakage minimisation		
	Using sustainable material	Re-usable crates	Environmental consciousness		
	Food waste mitigation	Processing food for value added products/derivative products such juice, cutting fruit	Cascades orientation Economic optimisation Maximisation of retained value		
		Trim and Re-package	Cascades orientation Economic optimisation Maximisation of retained value		
		Promotion and discount product	Cascades orientation Economic optimisation Maximisation of retained value		
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value		
		Showcase chiller	Maximisation of retained value		
		Automatic sprayer	Maximisation of retained value		
	Food processing	Technology for food processing	Maximisation of retained value		
	Digital technology	Online shopping	Economic optimisation		
	Social cohesion	Corporate social responsibilities	Social responsibility		

Barriers	Category
No information on CE	Knowledge
Perfect product specifications	Structural
Business risks	Financial
High investment advancing technology	Financial
High cost for upgrading packaging	Financial
Waste management is not prepared	Lack awareness to environment

Unavailable sustainable packaging in large scale	Supply chain

Case T

Pollution Prevention Strategic capabilities	Operational Capabilities	Actions	CE Principles	Outcome	Responses
Continuous improvement (resource)	Planning	Order management	Waste elimination	Reduce FLW	**Internal operation in waste prevention** *"Food waste is unsold product because they are damaged. Causes are varied. It depends on the handling, consumers behaviour, display management, technical problems such as electricity blackout that reduce freshness […] We have KPI [key performance indicator] that measure how much the breakage."(T-2)* *"Tolerance rate is diverse. As for me, in my store, here only 7% in total but each product can't be more than 10%. We keep that number not exceed from that."(T-2)* *"So that's why the handling during receiving process has to be very tight."(T-3)* *"When we first receive our products, if we really do not have good handling, if we do not focus, it will occur loss on us." (T-1)* *"The cool storage has a function to protect fruits and vegetables of significant temperature change it also prolong fruits and vegetables We have treatment, a spraying system it will be secured. 9 am, 1 pm, 5 pm and 7 pm. For vegetables we crisping-in, we make them fresh again so in the display there is specific place, there we put ice cubes and water, we dip there. Every one hour, we spray vegetables with cold water."(T-1)* *"We have several trainings, for training especially to reduce it [waste], there is training in handling. Food safety and the recent one is a new national programme, FFC, fresh for the customer, which means that the products sold must be fresh. We have an internal audit team, and they appraise the performance also food safety." (T-4)* *"If the product already accepted into the store and there is damage generally it would be BS or broken stock. Our administration term for this is broken stock. Then after 6 pm, the limit is 6 pm until 10 pm. If it is unsold, then it will be destroyed."(T-2)* *"Yes, it is weighted, it is recorded, then it will be input to product damaged of store losses. We destroyed, do not let the shape still be*
		Product specifications book	Waste elimination		
		Receive scheduling	Maximisation of retained value		
		Forecasting supply and demand	Economic optimisation		
	Operational process	Applying FIFO system	Waste elimination		
		Inventory management	Waste elimination		
		Improving facility	Waste elimination		
		Quality control in handling	Waste elimination		
		Minimum buffer stock	Waste elimination		
		Lean process	Maximisation of retained value		
		Crisping with cold water	Maximisation of retained value		
	Control	Waste prevention	Waste elimination		
	Learning process	Understanding product knowledge	Economic optimisation		
		Learning from stakeholder	Economic optimisation		
		Accumulated experience	Economic optimisation		
		Training for proper handling	Waste elimination		
		Training for quality control	Waste elimination		
	Culture	Implementing company value	Environmental consciousness		
		Strong commitment to reduce waste	Waste elimination		
Stakeholder integration (Resource)	Interorganisational cooperation	Communicating with many suppliers and contract seasonal fruit	Waste elimination		
	Information sharing	Demand data sharing	Economic optimisation		
		Regular visit	Economic optimisation		
		Intense communication with customers and suppliers for product development and new variant	Economic optimisation		
	High order learning	Learning from other network and association	Economic optimisation		
		Audit internal and external	Leakage minimisation		

	Using sustainable material	Re-usable crates	Environmental consciousness		*seen. Like watermelon or apples, when rotten, we cut into pieces to not be consumed. It is peril."(T-1)* **Collaboration in supply chain** *"Still use plastic for customers and only plastic bulk items. We use plastic roll, and then we sealed it, it is given labelled scales. Management has yet to give the facility for packaging like that [recycle bag]. But for plastic bags, some of our store not using plastic bags anymore as follow the government regulation that prohibits modern retail from using a plastic bag. It will be easier for us as retail. For me, I would prefer it will be prohibited. The plastics factory should be closed and told to produce a replacement. Then we can stop using plastics."(T-3)* *"It is already a regulation. It has been running for two months. We do not use any plastic bag anymore. It is zero per cent. In hope, the consumer will bring their own shopping back, or we pack it with cardboard that can reused, but there is one loophole that we still do not know the solution is plastic for fruits, because we do not know what to use ideally."(T-2)* *"For now, we have not found a proper solution for that, but we have begun to try to reduce styrofoam on displays by using plastic trays."(T-2)*
	Food waste mitigation	Processing food for value added products/derivative products as juice, cake,	Cascades orientation Economic optimisation Maximisation of retained value		
		Re-package	Cascades orientation Economic optimisation Maximisation of retained value		
		Promotion and discount one for undergrade product	Cascades orientation Economic optimisation Maximisation of retained value		
Shared vision (Resource)	**Technology adoption**	Cold storage	Maximisation of retained value		
		Showcase chiller	Maximisation of retained value		
		Automatic sprayer	Maximisation of retained value		
	Food processing	Technology for food processing	Maximisation of retained value		
	Digital technology	Digital technology adoption websites, apps, and social media	Economic optimisation		
	Social cohesion	Corporate social responsibilities from headquarter	Social responsibility		

Barriers	**Category**
No information on CE	Knowledge
Headquarters regulations	Structural
Business risks	Financial
High investment advancing technology	Financial
High cost for upgrading packaging will be effect in price?	Financial
Company image and misuse of the waste	Lack awareness to environment
Unavailable sustainable packaging in large scale	Supply chain

Appendix E

CASE A

Internal Operation

One of the significant efforts is to provide adequate training in handling to their employees. Case A believe that employees play a vital role in keeping the commitment to keep best practices, also affected by commitment of the leader in the direction of maintaining the quality of works. They started a campaign to reduce food waste in all steps of the process and put a banner in the packing house to raise employees' awareness. The respondent explained, *"Yes, first we do training, keep correcting what is going on with this, then maybe we are looking for facilities that can support this" (A-1)*. The company is trying to make it balance by providing facilities, not just demanding good work.

Having identified waste in the distribution stage inflicts financial loss, the respondent elucidated the cause of waste and stressed the need to overcome it. *"The distribution is the most atrocious, we are finishing the products well with reusable packaging but then, for example, there is a sudden change of temperature, and as result vegetables continue become bruised or wet, such as in transpiration. When the customers receive them, the fruits and vegetables have changed physically, it can be their colour that has turn yellow-ish, or they are wet, and then they could be rejected" (A-1)*. This reflects **environmental consciousness**. A challenge that may difficult to overcome is that the bruised will appears several hours later that sometimes missed in the quality control process such us take the product into cold storage. Those factors can cause the high possibility of the product being rejected and become waste. The respondent added that have applying standard operating internal firm but there is still rejected *"we have spent money on the packaging, labour and etc., but the rejection on the customer side is harmful" (A-1).*

Unmatched production and demand sometimes become a problem because the company has a cropping pattern and daily harvest. *"We not only think about the production, we will also think about preventing product not become waste; what would happen to the stock that has not been taken […] meanwhile we have plant every day. We make 100, 50 are asked for, that means there are already 50 surplus. Now, how we handle the other 50? […] the following days, the product will continue to be stocked for so one, two, three days have passed; meanwhile, for example, the commodity period has only one day left, so many vegetables have shrinkage because of that" (A-1)*.

The respondent further explained the cause of waste in the packing stage, and the company has been made the products that closely meet the retailer specifications; however, *"we grow living things […] not always produce the same quality and weight as retailer wanted. For* *example, they require lettuce to be packed in 250 grams, but the crops more than 250 grams, then we peel it until 250 grams, the leftover leaves become waste. Sometimes our employee scrapped it too much; as a result, the lettuce below 250 grams, we cannot just add the leaf; therefore it becomes waste" (A-1)*.

Case A attempted to reduce the risk of damage through intense observation, such as improve the product arrangement and reduce rubbing against each other, *"We try to reduce vibrations during the distribution process that causes damaged or bruised leaves" (A-1)*. **Economic optimisation** and **cascades orientation** appeared in case A by providing a task force for quick selling if they have a surplus, and they also distribute to the secondary market, e.g. hospitality sector.

In responding to waste processing, they admitted that waste is given for animal feeds and sometimes have to go to the landfill. Case A has started to have an idea to process waste. However, they are still looking at the best method for waste management, and this is because they cannot use their compost from their waste as they entirely use soluble fertiliser. *"I have no treatment, waste management, especially for the vegetables [...] but we want to process it to become something useful even though it is not always in the form of material" (A-1)*.

Collaboration in the supply chain

For traceability has become an issue and draws people attention, the respondent revealed that *"consumers nowadays are very critical about the traceability of all the products*" *(A-1)*. This awareness has emerged due to changes in consumption trends into something that is way healthier in some respects. *"Some consumers want to know where the fruits and vegetables come from and even do a small research on the product before they buy it" (A-1),* to ensure it is safe for consumption and has no issues. The company stressed that the brand is essential besides being part of marketing. It can also be used as a tool for tracing. *"We use a brand that makes it easy to trace, especially for end-users; they can easily find the information from the Internet" (A-1)*.

The informant also explained the possibility of substitute dependence on the soil as they start to change their technique to become fully aeroponic. The informant further stated that they had tried different things. *"Maybe, one thing we have done is substitute rockwool with peat moss, which is more environmentally friendly" (A-1)*. Therefore, the company has changed its choice of growing media into a type that is considered to be more environmentally friendly. *"Electrical energy, maybe especially for biomass" (A-1)*; the respondent expressed that the most energy being used in the company is electrical energy, as it is used to run the biomass system.

Moving on to the discussion on how the view company intends to use renewable material. Case A admitted that plastic for packaging is inevitable following customers' request. However, case A has taken the initiative in a more sustainable direction to use recyclable plastics. *"Yes, we are already [using recyclable plastic], so if previously it was not easy to decompose or break down, now the plastic can immediately be decomposed" (A-1)*. Furthermore, the respondent aware that plastic has now become a global issue. However, they cannot found any replacement packaging material available; therefore, some packaging still uses conventional plastic and illustrated one example in another country. *"In Thailand, they already use some materials from bananas for packaging, but it seems like it has not yet been applied in Indonesia. There's no banana farmer that lets their banana leaves be processed as packaging" (A-1)*.

Technology adoption

The company also uses an ozone filter for irrigation system to prevent crops from being contaminated by bacteria in water. Besides hydroponics, in their cultivation, the respondent revealed three systems that they have implemented. The first system is NFT or Nutrient Film Technique; NFT means the provision of nutrients that are as thin as film; the second is a substrate or drip irrigation that is dripped onto plants, and the third is a soil ground or processing soil that is the conventional way of growing. The respondent then explained, *"the NFT system is easier to manage and calculate the speed of turn over faster turn over. If it is said to be easy, it means it is easier to manage; each of the commodities has their own characteristics in cultivation" (A-1)*.

Social orientation

Due to the absence of waste management in the company, the respondent explained that there is another party coming to the company to personally ask if the waste can be used as animal feed. *"Now we have not yet headed there yet but there are people who take it for maggots. So, they ask us for the waste for free. Yes, we allow it, but it is not under our management system, it's other people using it" (A-1)*.

Barriers in adopting Circular Economy

The respondent explained that they had not yet found waste management suitable for them and did not have the facility for processing waste. If they have to provide the facility, they need to invest that are not related to their primary business. *"For people, probably the easiest way is to make compost from it, but to wait for it to be decomposed, there are many treatments that need to be done" (A-1)*. The respondent explained that the most straightforward treatment of waste for compost, even though it need treatments for the decomposition process. The respondent further stated that waste ends up in the landfill because many things had to be managed. The company does not recover solid waste from leftover vegetables because they mainly use soluble fertiliser, and a large proportion of cultivation system is using non-soil. They need more human resource to help them managing waste.

CASE B

Internal operation in waste prevention

Case B cultivated in the open system, they realised that weather is the most challenging in doing cultivation which causes of crops failure and waste. They do several actions in waste prevention, the most important for this group of growers is the use of superior seeds that will be stronger against weather and pests. They have the capability to understand the agro climate and have sensitivity to the weather and environmental changes. They select which variant of seeds that suitable for their land to be cultivated. The informant emphasised that *"not all seeds will be suitable to be planted in our area because each place has its characteristics […] and we need to understand that" (B-1).* Long experience seems to their advantage in identifying the weather conditions. Before the dry season come, they prepare a water reservoir so that plants can still grow in the long dry season. In dealing with this, case B usually ask for support from other growers. *"We face difficulties during the dry season. We have to make reservoirs in tanks during the rainy season for irrigation purposes [...] we ask support from other growers" (B-1).*

Products that are excluded from specifications that were unfit for consumption are used for animals feed or to be put back in the land and will be processed as compost that support **leakage minimisation**. Due to the proximity with nature, case B argued that waste they produce is organic therefore the common actions are used for composting, animals feed, however sometimes waste end up burnt in the landfill as well as their treatment of plastic mulch after the end of life as it is the common practice for years. *"Yes, but if during the dry season, if there is waste around here, the waste can be used for livestock, breeders, and freshwater fish. Maybe there are ducks, there are goats… If it is not suitable for consumption, we leave it in the fields or for compost" (B-1).*

Case B also actively seeking a better process, attempt to develop and make their seed when they experience difficulty to obtain seed and fertiliser. They process animal manure for organic fertiliser although they have still need to buy chemical fertiliser, *"Yes, we usually rely on manure for organic fertiliser. We are very different from the rice fields, as rice fields rarely use fertiliser, but if we are in the highlands in the horticulture area, yes, it is imperative to use fertiliser… because if we use only chemical fertilisers, it's probably the microelements that are different" (B-1).* Some of the actions in preventing waste are product arrangement during delivery, not stack too high, delivery schedule and use a refrigerated truck for delivery to maintain the freshness of products that aim **waste elimination** and **maximisation of retained value.**

Collaboration in the supply chain

Strong engagement with the community appears in case B where they always hold regular meetings once a week to communicate and coordinate with the members besides keeping in touch with social media like WhatsApp, information sharing ranging from planning, updating the technology, trend and solving the problems. *"First, about cropping patterns, anticipating the weather, then our needs, then there might be new technological innovations, or there might be new seeds because the seeds are not always in good condition in the long term. So, maybe from the seed producers from 2-3 years, at the most 5 years later, then we will need to find another source of superior seed." Regarding seedling input, case B get from their network "we attempt to make seeds, but the rest we have to get from Lembang" (B-1).*

High specifications are usually set by modern retailers because they want the best grade. Although not directly supply to modern retailers, case B often visited by modern retailers representatives to the farm to monitor and growers are expected to maintain continuity and quality in general, but not about cultivation *skills "they don't give much input to that area" (B-1).* In a selection of packaging, the company only follows the requests from the customers, so they usually use plastic and styrofoam. *"I think we can recycle it, but it is in the modern retailers' hands" (B-1).*

Barriers in adopting Circular Economy

Case B still encounters various obstacles in implementing CE. Case B has no suitable technology because of land conditions. Another problem is human resources in keeping best practice cultivation and handling process in improving handling products and managing waste not to be burned. Building good communications with several parties is something the company has been trying hard to improve. *"We have tried to communicate but sometimes it is not easy, maybe because we small and do not have power" (B-1).* Lack of support from consumer to support environmentally packaging is seen a barrier because case B only follow customer demand, *"If they told us to do so, we will follow their request, as long as the cost is realistic" (B-1).*

Oversupply in the market cause price drop and unmarketable and being waste and wasted natural resources. But the relationship between supply chain actors does not always work well. On the other hand, there are weather factors, such as in certain seasons, when heavy winds often damage and knock down the plants. *"The weather, maybe like yesterday's wind, the wind made the plants fall, they fell down" (B-1).* In addition, the negligence of growers also often occurs as they forget to spray or add fertiliser. So that the product grows a fungus and attacked by pests.

Case B concern is how limited growers are in acquiring market information as it is very important to them; what growers know is only about cultivation but limited access information of the market demand, such as local needs; many growers do not know what is required nationally. The data often do not match, because the data taken are usually from agents. Case B expects more transparent information and suggest there is a need to regulate the mapping area so as not to oversupply that can cause wasted resources. *"Yes, we really are, how independent we are […] growers can be taught to make the seeds, how about the cultivation technology? Maybe with efficiency tools, then how about the market readiness? Well, often what we are a little strange about is the growers' limitations for market information. Because market information is very important, on the other hand, the commodities planted by the growers are planted here, planted there, they're planted, but they are not connected, how many they produce, what may be local needs, how many nationally you don't know. The data doesn't match, it doesn't accurate because the data taken is usually from extension workers" (B-1).*

CASE C

Internal operation in waste prevention

Another factor is soil management. Having experienced and understood the adverse impact on the use of high pesticides and other chemical substances made them prudent to use any chemical substances, thus demonstrating **environmental consciousness**. They have to restore the soil and take about two years before the soil is optimal. *"I have to restore the soil that has been really damaged by chemicals; it takes a really long time – about two years. So, you can imagine how long I did not get income [...] just had to invest in the soil. Then I found guano that has a high content of nitrogen, phosphate and potassium [...] key nutrients for plants" (C-1).*

Case C believe that understanding the characteristics of soil is the key to produce high-quality products. Therefore, in line with their niche target market, they focus on various exotic plants suitable for their farm. *"We know what we are planting what are suitable to our farm, and what minerals are inside, otherwise we just wasting our resources" (C-1).* The seeds used by the company are imported seeds; they rarely use local seeds due to the suboptimal growth. Some of the boosters and additive they produce by themselves for organic pest control, *"I spray using red onion, coconut water, mineral water in one glass of mineral water; I blend, I squeeze it, so maybe it can fit into one bottle of mineral water […] keep spraying it, and it will crush the kausim" (C-1).*

Due to the open system cultivation, the weather and pest are often affecting harvest performance. The respondent illustrated the example when they planted a lot of carrots, but they washed away due to heavy rain. *"Sometimes it is beyond predictions, like yesterday, it was rainy season, high rainfall. The carrots were just washed away" (C-1).* Case C also implemented a cut off system to minimise cost and waste when they identified suboptimal plant in the early stage of growing. The plant then will dispose of before harvest. *"At the time we plant, pick fruit, we throw away rather we rejected […] Once it starts to bear fruit, we know that instead of throwing it away waiting until ripe, nutrients are there, so it wasted a lot" (C-1).*

Responding to the question of waste, the company reluctant to answer, because the respondent believes in *"the law of attraction […] to be honest, I don't want to talk about waste, the more I talk about waste, the more it will come" (C-1).* Many reasons of food waste: problems with growth, poor harvesting technique and handling process. Previously they were recorded food waste, but then they stopped due to personal beliefs. If there are think about waste, there will always be tolerance, so they just focus on producing the best with standard operation in the firm and their mindset is they do cultivation is not on purpose to produce waste, *"so, if I think about reject, it will break my concept, I don't want to ruin my foundation, because, ok that's alright, there will be rejection, it is fine, finally the negative thoughts will resonate and my product will finally reject and we cannot enter the market" (C-1).* The respondent states that there is apparently no rejection from buyers for unqualified products, as they always try to behave and react positively in everything, including in handling the waste problem. If they experience off-grade specifications, they diverted to the traditional market with a consequence of lower price range.

The company is currently developing fruits based on products size and undertaking research observing consumers' habits, i.e. how fruit can be consumed to reduce the chance of turning into waste. *"We go towards developing a personalised size of fruits. One family, usually they have a maximum of two children, right? Then, for example, if they buy watermelon up to five kilos, they cut it, the leftover is stored in the fridge, but they often feel it is not fresh any longer; finally, the leftover is given to their domestic helper or even discarded" (C-1).* The company plan to develop personal size product and convinced modern retailers to also think towards that direction. Case C also processed food as part of product development such as paprika canned that exhibit **maximisation of retained value**.

Collaboration in the supply chain

When it comes to packaging, products in farm location uses reusable baskets but unrecyclable plastic packaging for products sent to modern retailers. The company aspires to use baskets even when they reach modern retailers so products are well-protected and will not become dirty or blemished during the transfer. This reflects **environmental consciousness.** The respondent admitted that the company does not have any certification, *"I learn by myself, get information, learn how to produce high quality products. I was rejected 13 times with the same modern market, is hard my product to enter to that store. Finally, my product was accepted, for me it was the real certification. I don't know such sophisticated terms" (C-1).* The process oe evaluating the agricultural system so that it can product quality product reflects the **leakage minimisation.**

The respondent held a gathering in the community consisting of women and housewives, that are considered as the decision-makers of buying household products, to introduce eco-aesthetic vegetables to them, i.e. celery sticks. *"I introduce them and try to educate them by showing that the products are not only affordable, but also good for health" (C-1).* The end consumers and modern retailers have included in the list of parties that the company pays attention to, such as holding talk shows in retailers' stores. This programme is one of the ways to educate end consumers about healthy products or introduce some more exotic vegetables as part of product development.

Barriers in adopting Circular Economy

Following the difficulty with water conditions in dry seasons, In the future, the respondent revealed that he was thinking of making a reservoir, but this problem was still constrained by the capital required to build it. Touching on the issue of integrated agriculture, the company responded positively, because the ability to always be optimistic is in line with the company's belief that integrated agriculture is possible to be implemented in Indonesia. *"They have their own patterns" (C-1)*. the respondent added. Because of upholding transparency, the respondent revealed that the pattern of enterprise is widely known by various parties, both in terms of fertiliser and farmers' policy.

CASE D

Internal operation in waste prevention

Case D admitted that they have implemented what they call as 'integrated farming system' it makes them already have sustainable mindset and applying the system from the very beginning of the farming process. Case D showed **environmental consciousness** and **leakage minimisation** by processing waste into fertiliser, *"We implement an integrated farming system already, so actually, this is from the local genius of the founding fathers… if you want to do farming you have to have animal husbandry, the leftover vegetables are used for their feed, from them we get the manure for fertiliser [...] as well as we make organic pesticides, If we can make it ourselves then we don't have to buy it" (D-1).* They also implemented permaculture, which aims is to be ecologically sound and economically viable.

"We implement permaculture, and we synchronise all activities so as not to harm the environment" (D-1).

The respondent does not deny the fact that the activities in their company are not all organic, has revealed that they still depend on the use of pesticides and fungicides, but under control. They are aware it also threatening soil fertility and adverse impact on the environment being carried by wastewater. *"Not organic, is unavoidable using chemicals, […] it is so hard not to use any chemical substance [...] but within the terminology of Integrated Pest Management, so growers will understand that the treatments they will apply are used properly, according to the safe dosage, without leaving an unusual high residue" (D-1).*

Case D exhibited **cascades orientation** as they are claimed market-oriented and understand that agricultural products are not uniform. They must be able to sell all products based on the specifications and distribute them according to the market segments to achieve **economic optimisation**. *"[…] because not all the quality and qualifications of agricultural products enter the modern market, it means that we are also targeting other market segments such as restaurants, including traditional markets. So, there will be classifications of products" (D-1).* In the post-harvest process, the respondent expressed that it is very important to follow the applicable standard operation procedure in minimising errors within the process, so that waste could be prevented. The firm only targeting other market segment and not processing crops into value added product as they do not have any facilities for processing products.

Case D had set up the standard operating procedure to maintain the quality product that is enforced in their operations including handling the products. Some of the obstacles is they do not have refrigerated trucks for delivery, therefore to overcome the limitation they set delivery schedule as they claimed will minimise the possibility of product damaged and **waste elimination**. *"Yes, for example, if we send the products to Jakarta, we send it to the distribution centre, so they open up at 2 am to receive goods; this means we will harvest today from 10 am to 2 pm. Then we process the sorting, grading, and packaging; at 10 pm we send it out, and two hours later arrives at Jakarta" (D-1).* This reflects **maximisation retained value.**

Collaboration in the supply chain

Case D has a strong relationship with international NGOs, from the Netherlands and Japan; the relationships brought many advantages for case D in assisting cultivation, evaluation, learning, innovation and updating information. Information sharing plays an important role in the development of various aspects. They have regular meetings online with the corresponding person both in Netherland and Japan as well as the representative in Indonesia who visited every two weeks. The NGOs assisted in cultivation, soil analysis, and applied technology such as greenhouse system and irrigation fertigation. *"It is a consideration from* *the start that the soil analysis is important to be conducted, so we can determine how much chemical content is needed for the soil […] we are also assisted by them from the cultivation and technology for agriculture by PUM from the Netherlands and JICA from Japan, we receive a lot of transfer of knowledge from them" (D-1).* This reflects **leakage minimisation**.

Regarding certification, the respondent commented that they do not have any certification. *"Until now we do not have any certification either Prima 1 or 2 or Sucofindo" (D-1).* The process of obtaining certification from the government is considered complicated, so they feel they do not need it as the customers do not require them to have the certification. In addition to that, case D fully assured that being assisted by the international NGOs is regarded as adequate and customers trust them. *"In fact, those NGOs is from the customer network, from the market side, they trust more in their network, right?" (D-1).*

Maintaining good relationships with customers is vital, in this case, are modern retail representatives to update information related to market trends and product development, *"Well, we communicate with modern retailers, about what kind of trends are currently happening. That is the time to chat with local parties because we also have good connections with people in the Netherlands, and with people in Japan" (D-1).* The company revealed that a mentoring model is also provided by partners such as modern retailers,

The company explained that the use of plastic depends on the demand of customers. At present they do not deny the fact that the use of conventional plastic is still dominant. *"Still, still (we still use plastic)" (D-1).* However, since 2019 case D has started using reusable crates and corn-based plastic so as easy decompose as a form of cooperation with modern retailers; They started using environmentally friendly following the modern retailer demand. *"Yes, that was because we collaborated with modern retailers, accompanied by JICA. The direction is like this […], the direction is like this, yes we follow but give the solution too" (D-1).* This reflects **environmental consciousness.**

Case D is proactive in forming a collaboration with various parties, including the government; they have been able to build a collaboration with state-owned enterprises which has ultimately helped them in increasing production and providing capital for growers. *"We are collaborating with several BUMNs, such as PT KAI, then with PT Bahana, because this BUMN has a PKBL programme; it's like a Community Development Partnership Programme. So BUMN distributes partnership programmes to our fostered growers, to increase production capacity, for capital for the farmers" (D-1).* They also received CSR support from the Indonesia central bank which has helped them, especially in terms of technology application and infrastructure to increase production capacity especially for a commodity that causes inflation. *"[…] for technology, it is* *the infrastructure that we received through CSR support from Bank Indonesia […] to be able to increase production capacity" (D-1).*

Social orientation

The company sees an opportunity to sell in market segments for the lower economic class because people who come to traditional markets will not fully pay attention to every detail and specifications of the commodities. *"For those who enter the supermarket, it means they're being prepared to go to the supermarket, the product that does not meet specifications means they're being prepared for the traditional markets" (D-1),* the respondent added. The company also involving the senior students in the business process as a way to provide training and work experiences which will be useful after the students graduate.

Barriers in adopting Circular Economy

The process of certification is rather confusing and difficult to follow instead of being helpful for case D. For administrative support, issues such as shipping requirements to various modern retail companies are making it very difficult. *"To get agricultural production following market demand, well actually for administrative matters like that it should be the government who helps us, it should not be us filling in things like that" (D-1).* The respondent responded to the lack of government support from several aspects, especially in terms of bridging between the company and the market.

The company explained that there were some obstacles in applying a sustainable system in managing environmental problems; this is still related to the condition of the supply chain itself. The respondent revealed that *"If we talk about the supply chain, […] the length of the supply chain, that's the problem, so from farmers to collectors, collectors to dealers, wholesale markets, wholesale markets to small markets, small markets to vegetable traders, vegetable traders to consumers; this is a very long supply chain that creates a high level of damage to the vegetables" (D-1).* Because of the extensive form of the supply chain and the many actors involved in it, the company revealed the difficulty in making everyone require orchestration to achieve a single goal. Estimates of production are often mismatched to the market demand thus surplus occur. *"We have calculated how much chilli is needed in Indonesia, but many restaurants are closed, so that becomes over-production; that's one of the conditions" (D-1).*

CASE E

Internal operation in waste prevention

Some of the actions in preventing waste that can be identified in case E were managing the time of harvest and classified the products based on their distribution channels that demonstrated **cascades orientation** and **economic optimisation**. They understand fresh produce have different sizes and since they faced slow market selling, they attempted to innovate new market export. *"Our produce is divided into two categories: A and B [...] It is combined into one grade export. Below that range will be sold in domestic [modern and traditional] markets" (E-1).* Another effort that was done is processing below specifications into derivative products such as crisps, *"small fruits [...] we process further for crisps, assortment, dodol" (E-1).* Some products that cannot be consumed is usually asked by the community for animal feed such as for ducks, cows, and fish.

Collaboration in the supply chain

Case E have regular meeting to ensure information flows smooth as training section for growers to handle problem in cultivation. Some of the topics discussed are related to the price, market, solving problems. In obtaining some sources of raw materials case E organised with the members. Due to the long life of the salacca plant, case E reassured about the seed for rejuvenation of plant as they are also capable to make seed. Case E empowered the group to procure fertiliser, *"we have a group system. So, there are groups called cattle rancher. Animal dung will be processed in compost house to fermented. After fermented then it will be distributed to the farmers in accordance to their groups" (E-1).* However, sometimes they experienced a shortage, thus required from other sources.

Barriers in adoption Circular Economy

Case E have to face a competitive market with other seasonal fruits, sometimes oversupply due to many areas in other islands are planting salacca fruit. They ever experienced have to donate the products even got rejected because it was too much and end up being wasted. *"once we had the experience to donate to the boarding school, it has about 6 thousand students, per student, it already has 3 kilos. Even when I tried to give them still got rejected, because is too much, eventually had to be thrown away" (E-1).* The company has their viewpoint about invisible demand and low domestic purchasing power, *"It fluctuated due the market dynamics in this competitive industry, there is a saturation point, we must expand the market to export" (E-1).* The absorption is low in the domestic market that suggests the need for product development, such as make derivative products, canned fruits, and exporting the products.

Even though the government gives them guidance and training on how to improve best practice cultivation, they are still lacking in supporting distribution and technical know-how to implement CE. *"I don't know what CE is […] but if you mean integrated, I think we had implemented that" (E-1).* Case E was expecting support from the government in expanding distribution channels and providing the guidance for processing fruits *"[…] we need support from the government for distribution of salacca to other islands because Indonesia is an* *archipelago country which is not neatly organised and they need to start to think about processing fruits in large scale" (E-1).*

CASE F

Internal operation in waste prevention

Then they improved post-harvest container for transferring the products from farm to warehouse using reusable crates to protect vegetables and fruits. *"Well, now we use lots of crates. So, the post-harvest process has begun to improve. There were lots of sacks in the past […] now we use plastic crates" (F-1).* This reflects **environmental consciousness.** The post-harvest process has become better. *"Back then, we use used plastic bags, but now we have used plastic crates" (F-1).* The change from plastic bags to crates is proven to successfully protect the commodities from getting damaged as it is moved to the truck. However, growers do not want to record how much waste they generate as it is not common. *"People here does not want that knowledge of tracking or recording like foreigners […] There is none. People never calculate that" (F-1).* The respondent added that this waste occurrence and method depend on the growers' behaviour, *"Whether it has to be surmounted or not, it depends on the farmer where they sell their product. Whether it can be sold almost 100% immediately, those discarded crops will be fertiliser" (F-1).* How the farmers send their products and their selling power is vital in this matter. Therefore, Case F is trying to make a delivery scheduling to its supplier to address the waste problem. This reflects **maximisation retained value.**

Collaboration in the supply chain

They keep learning and review of the farming methods. They claimed that they have a strong relationship with the local government. This was formed in the hope that agriculture can be shifted gradually into Go Organic. *"Currently, the cooperation with the Batu City Agricultural Service is excellent. They encourage us to use organic manure fertilisers. The local government distributed organic fertilisers to the growers. So here, the land fertility is preserved" (F-1).* The local government also provide training from them, *" Guidance, training, workshops, exhibitions are also provided by the government to growers, not individuals, so that these legal growers group can also enjoy all the programs from the Ministry of Agriculture to the Agricultural Service" (F-1).*

The company explained that they had applied an integrated system, starting from breeding seed, planting to the packaging process, use cow dung for fertiliser. However, they admitted that waste management is not practical. *"We have cows ranches that we manage, and we use the dung for fertiliser and biogas. Recently, we collaborate with PT Pegadaian to manage waste" (F-1).* The respondent explained the support of the local government for processing waste. However, some of the growers occasionally do not follow the method. *"Sometimes the application that is still low for growers. But the government also uses rules. We finally know how to manage plastics. There is a place, and there are facilitators from Pegadaian [pawnshop], there are facilitators from the government. So, there are parties who manage the waste in Batu City" (F-1).*

Case F further explained, *"We are assisted with the cultivation method, our cultivation we form a collaboration with PKPHT Brawijaya University, lecturers who carry out dedication program, continue to foster growers based on technology development, continue to be supported by the institutional strengthening of various parties. Finally, there is a success" (F-1).* The information they received from collaboration with many parties helps the company in their growth as in improving their cultivation method and technological adaptation.

Case F has to set the vision that is supported with strategies in order to keep thriving as they stated that *"we must be open about technology and information, keep updated with regulation, with our current team that's working right now, we hope that our product outcome will have a certain quality in here and overseas" (F-1).* The respondent mentioned how important it is to be more open about technology adoption and information sharing. Besides keeping them updated and increasing their knowledge, it will also help them work more effectively and efficiently, leading to better grower's performance product outcome. *"We must be technology literate, information literate and regulatory updates" (F-1).* This reflects **waste elimination** and **economic optimisation.**

Technology adoption

The utilisation of technology has started technology adoption to boost their productivity, and respondent stated that *"The most advanced agriculture in Indonesia is Batu City, to prepare a soil people here not using tractor anymore but excavator. Some use greenhouse and rain shelter, the one that's more impressive the use of a drone for pesticides, some also implement demonstration plot besides mulch" (F-1).* In the post-harvest phase, the respondent revealed that they also had used machine for grading. *"Cold storage, for grading, there are members who have used machines, such as apples. Just a simple machine" (F-1).* The respondent emphasised how the growers have gradually used more advanced technology, and some who have spacious land even use more modern tools. *"Some have used hand tractors, and it is technology. Suppose the excavator is only growers who have vast land and one stretch. Well, they use an excavator, which is only for soil management. They also have tools for making holes in plastic mulch, not manual again" (F-1).*

In the future, the company by showing its desire to keep developing technology. *"Apart from the knowledge we got from other parties, we also conduct comparative studies to other regions* *to upgrading knowledge. If you get knowledge, you can apply it more efficiently, you will use it here" (F-1).* Some growers now replace the bamboo with the stake, *"for plant stakes, these stakes used to use bamboo only, now use takiron stakes that can be re-use. But because of the fear of growers, the stake will be stolen, well, it is only some of the growers who use from the factory-made stake" (F-1).*

Barrier in adopting Circular Economy

The respondent stated that *"If sustainable activity in agriculture is just like this. Yesterday I immediately asked the intern who are apprenticed there. In theory, it is considered really decent. There, around Gresik, it has land, then the fertiliser is said to be from the chicken and goat livestock. There are some that have fisheries, and then it is planted there, then finally they are also making outlets there, used for sales. However, they suffered a loss. Theory, for theory, for learning such as recreation areas, that is all, agricultural education" (F-1).* That assumption that the integrated farming system most likely to bring loss for the company economically has stopped the whole company from implementing it. Even though the respondents expressed low faith regarding the integrated farming system, it does not close the possibility that it will not be able to be adapted soon as the respondent explained that *"Yes, we do want this group to be sustainable, we do have hope but to handle the human resource is difficult" (F-1).*

CASE G

Internal operation in waste prevention

A cycle that created by respondent help them to minimise waste, the possibility of the surplus is not going to happen when proper planting cycle is conducted although there still a possibility of loss because of shrinkage. *"The loss still happens because of shrinkage, technical problem, and some of the exception. We hit by the pandemic that made us lose in economic, and we had to dispose of around three tonnes of lettuce" (G-1).* Furthermore, the respondent explained they use imported seeds to produce good quality and gain optimal weight. *"For seeds, we used imported because we are committed to quality. Imported seeds adaptable compared to the local seeds" (G-1).* However, somehow waste is still unavoidable, such as they supposedly plan 5000 seeds, but they will not grow equally. *"Because definitely there is waste there, but if there is loss one, it's only 10%. So, from 5000 seeds, only around 4500 will grow, but there must be, on average" (G-1).*

A product with good quality is a yield of a well-managed standard operation procedure. In order to surpass the consumer expectation, case G proper in selecting seedlings and maintenance by routinely checking nutrition, PH water, and room temperature. *"The treatment* *is more likely about checking for nutrients. First of all, nutrient. Second, the acidity of water or PH" (G-1).* During the plantation case, G preventing waste occurrence by providing the *"Actually even though we set up many blowers the temperature will still be high. The function is more like to decrease the temperature of the room" (G-1).* The respondent explained how they try to set up many fans to lower the room temperature since the natural condition of the plant is not in the lowland. *"If it gets too hot, then the vegetables will be withered. It is not dead but more likely to get withered" (G-1).*

The company strived to improve by evaluating every three months. *"We do have something named business review to evaluate our performance and set up the next plan. We updated the contract with our customers. It is not only about renewal, but we do price updates and negotiation, or for example, we want to reduce the quantity or add new variety. We do it every three months […] we do not want to sell to traditional markets because we do not face price wars with conventional farmers" (G-1).* This reflects **leakage minimisation.** The respondent explained they are not diverting to other channels such as the traditional market because they have a specific target market and made a proper plan to avoid surplus and price volatility in the traditional market.

The delivery process is essential, and the respondent stated that they create delivery scheduling and only use an ordinary truck for shipping in a short distance, *"No need [cooler] because if it is around here except if we send it out of town" (G-1).* Furthermore, the respondent explained that they have consumer from Bali. If they want to send the commodities to them, then the usage of chiller is mandatory, *"Automatically, we will use the refrigerated truck that has chiller in it" (G-1).* This reflects **maximisation retained value.**

They explained how to process waste. Old leaves will be collected for fertiliser, but they cannot use it because they only use soluble fertiliser. *"The problem here is we do not have [livestock], so as a solution, we use the waste for fertiliser, but sometimes we only pile them up. They will end up burned down" (G-1).* As part of the commitment to comply with food safety and the environment, they are not using any chemical substance for any of their plants, such as pesticide, *"We do not use any pesticides" (G-1).* These efforts they do to form more environmentally friendly and increase safety for their product, the **environmental consciousness** appeared in case G.

Collaboration in the supply chain

To build a proper relationship, the respondent mention how important communication is. *"We interact directly every day, we search purchasing department then we ask their kitchen section, who is responsible for it. However, we usually deal with the head with the kitchen department or the chef" (G-1).* The respondent explained that everything must comply with agreement and consumer is satisfied, if there is one aspect that is not fulfilled then the company will take the responsibility and offer compensation. *"For example, in lettuce they need certain wide of the leaf or etc. If it is not fit with their request, then we can get penalty. For example, if we failed one plant then we will give them two in return, or we replace it with the value of money" (G-1).*

To keep update with current market condition, some research they do regularly also help them to gain better knowledge. *"So, we can read the graphic, demand from who, how about people in kitchen department. Every day we interact with them. We also update regarding selling and market trend, in terms of business market. Second, in terms of market demand it usually invisible we really have to update frequently, market research, we are strolling around in the market and ask people there" (G-1).* This method uphold by the respondent to gain better information especially market business and the demand. In this way, Case G will get many channels to distribute its products. This activities reflects **cascading orientation** and **economic optimisation**. They choose the target market according to the product they have without being processed first. Case G alluded that the process of learning is through their network of growers. *"Many of us also survey directly to the field, learn from the growers" (G-1).* Their value and method in farming is something that is really to learn directly from the growers will give insight for the company for their development.

In relation about their relationships with the seeds supplier. *"Definitely. We are included as the consumer who buys the most amongst the other" (G-1).* The respondent explained that the supplier give advice about farming. Understanding that they plant non-endogenous they through trial and error, *"Firstly, we are researching that for the first time we ever bought the seeds from the importer. We did research in anticipation for example the seeds supply is hampered, we actually have three kinds of imported seed: Bejo and RZ from Netherland while Jhony seed is from America. If it's hard then we don't have another choice but to use local seeds. These local seeds we observe in sense that we still obtain the specification that we wanted" (G-1).* With good relationship with certain supplier the company make sure they receive positive input and benefit from them *"Our seeds importer also produce the fertiliser even though not commercialised because they only cooperate with partners, they also sell the rockwool. So those three items we get from one supplier it already cut down the operating cost" (G-1).*

Technology adoption

To support the hydroponic system, they only use a water pump from a reservoir of nutrient water, lift it with a pump and then drain it following gravity. *"Resource that we feel most important is electricity […] The electricity is efficient because we only use one pump" (G-1).*

The respondent point out how importance the availability of water for them and they circulate water, *“Yes, we made a well specifically for it. The water will be circulated underground then it will come back, we do have pipes that is pointed out back to the reservoir, before get there, there is small pond that’s the function is for filtering so when the water return to the reservoir clean, if we want to filtering water it is on that pond” (G-1).*

In the future respondent expressed the company intends to properly handle the organic waste since it also cause methane gas *“Last April we intent to create landscape, something like garden landscape, we will try organic also it will add the aesthetic. Maybe it will start from there, and later we will make decomposer, a place to make compost” (G-1).* One interesting view about the use of technology is wasted resources. They said that investment in technology would be calculated in the return of investment. That makes the operational cost high. The future aspiration in adoption of technology is solar panel. *“Yes, if there is technology that might help us, maybe solar panels, maybe in the future it will be the most needed in the future Yes because yes in Indonesia, this is a monopoly of PLN” (G-1).*

Information is a critical factor of improvement, and the respondent pointed how the information itself is helping them to keep updated in a fast-changing and competitive environment, *“Yes, because we do not have any agriculture background, so we need to stay updated” (G-1).* The source of information for the company is the internet, much various information and adaptation they have obtained from there*. “There are no special resources” (G-1).* The respondent mentioned how he used the internet, especially Google, frequently. This case also used digital technology to learning about cultivation and follow the trend that reflects **waste elimination** and **economic optimisation.**

CASE H

Internal Operation in waste prevention

Respondent explained that they did not have a specific definition of the waste but associated with unsold products because damaged or below specifications. *"So definitely, it called off grade, we have on grade, we have shrinkage products. We have BS reject. So if it's off grade; it looks good, the length is good, there aren't all kinds of insects and all, but it is basically long over than it should be" (H-1).* They repurpose waste for animal feed and compost, but growers ignorance often leaves waste untapped. *"Some of them being taken and used as cow feed. For example, peel mustard and cabbage. But actually, it still be used even when it is backfilled, which the growers does not realise that it is actually become organic, becoming the next cycle of fertiliser" (H-1).*

Cropping patterns must be carefully estimated. *"We intend to plant one ton, the yield one ton and a half, yes, then we sell it to the modern market. Finally, we have a volume there,* *increasing in population, in management, increase in control" (H-1),* to anticipate these surpluses, the company tried to press on the sales to several modern retailers. This causes an increase in volume, increase in population, management and control. *"So for example, if we want to increase production by only 10%, it means that the area must increase, meaning that one cycle must increase. If for example, the first cycle is well, before the broad limitations, limited control, limited mobility. All of that must be reviewed. Agribusiness is complex" (H-1).* When something like this happens, respondent stated that the company have to do an evaluation and review.

Collaboration in supply chain

They received corporate social responsibility from one of the modern retailers to make biogas for electricity. *"From the CSR of modern retail, we got assisted to make electricity from biogas. When the cabbage is harvested, the remaining leaves are eaten by the cow, the cow's dung enters into the biogas canister, then the biogas on the stove becomes electricity and provided light for the packing house. That is their hope but was inefficient, and growers do not understand" (H-1).*

Case H received support from the university that helps them improving farming management, variety of products development and packing house management. *"Yes, until now, Unpad has supported us in many ways. Oh, from the farming management, new variety plant, packing house management" (H-1).* With the government, they are given tractors, cold storage, rain shelter from the central bank to increase productivity *"we are included in Bank Indonesia Cluster to be part supporting inflation control, we received tractors, cold storage and rain shelter" (H-1).*

The company did not deny that they continue to use plastic for packaging; instead, the respondent explained that everything comes down to the buyer's guidance and the market. *"Yes, that is a legitimate demand. Requirements. That means our packaging must be made of plastic. The mayor stated yesterday that styrofoam could not be used. Then, when we use the tray as reusable crates, the cost per pay increases" (H-1).* This reflects **environmental consciousness.** According to the respondent, the packaging issue is fundamentally a matter of communication and relationships between the company and its customers, market, and the government*. "So far, plastic just burned. To be honest, we have been in that situation, where we move to food-grade packaging. However, if the feedback is unbalanced, what is the point? Even so, what is the ultimate reward for us? If the requirement must be made, then we must comply. I think back there, communication between us and the market, with the government, with friends who really want to cooperate with us" (H-1).*

Barriers in adopting circular economy

Case H admitted that there were unavailable materials that supporting the environmentally friendly movement. Lack of environmental awareness is also an obstacle to implementing CE, and many growers are not processing waste and burn it in the landfill. While case H lacks the knowledge necessary to practice CE, it is associated with integrated farming and sceptical with CE. It is about integrating agriculture and livestock so that livestock manure can be used as fertiliser for crops. However, this requires a large area, and growers in their groups continue to struggle with fluctuated selling prices, making them reluctant to adopt new systems. *"This is cattle, and this is the farm, then the manure for farming. It was done decades ago. So it should be more in the direction as a whole system. Oh, I planted, how many days will be sold, buy by whom, at what price, with what payment. This packing house as a logistics function, oh, with the market as a market cooperation partner, oh, with the bank as the supply chain finance. Now, it's call integrated. People from Japan have come here. They tell us a lot about Japan and so on. I said We do not need that standard. What we need are production and price. Indonesian growers need that" (H-1).*

CASE I

Internal operations in waste prevention

Respondents added that growers do not use special rejuvenation plant rotation method for soil fertility, which is perceived as a common practice as part of soil management. What they do is focusing on maximising the use of compost to maintain soil fertility. *"There is no soil rejuvenation here, in fact there the usage of land is unstoppable every season, so we use compost as the alternative and try not being excessive in term of chemical dosage, as the result our soil is always fertile" (I-1)*.

Case I explained how they are actually has limitation on processing waste there is no waste management that can help process waste, other than what is commonly done for animal feed and compost*. "Because we are as growers, what else do we want? No more ideas. Meanwhile at the meantime we don't own any adequate tool to process it. So, yes, we give it people, use it as feed, or compost" (I-2).*

Collaboration in supply chain

The pesticide manufacturer also assisted case I in the cultivation as explained by respondent, *"The pesticide manufacturer come visit the farm. Teach the application of pesticide, introduce the variety, communicate the problem, the finding solution. They teach safety, use PPE, gloves. Because the first exposure is not a problem, not the nose or eyes, but the skin" (I-2).*

Responding to collaboration with the government, respondent expressed their opinion that technical supports are adequate, but they require government intervention regulating supplies and prices. To prevent surplus and imports products flooding the market, resulting in price drops and unharvested, ultimately cause food waste*. "The government must be brave enough to do mapping of the region or for example, production center. Production center for the needs of each market, for example, this market needs 100 tons, the centre is from anywhere per day, right? There is no certainty in us, even though sometimes the government told that there is a shortage of supply. Well, but when growers nearly harvest time, for example, chili, when we nearly want to harvest a lot, how come there is sudden import chilli? Change of land function also needs to be addressed that threatening food security." (I-1).*

Respondents revealed that at this moment, the packaging they use to wrap fruits and vegetables are plastics, cardboard, and styrofoam that can reuseable. They attempt to collaborate with one of bank to processed waste. *"Yes, cardboard, plastic, and styrofoam, we just follow the customer's request. I know it causes the environmental problem, but we have no choice. Recently, one of the state-owned banks has an idea to help waste processing, but this still at the concept stage" (I-2).* This reflects **environmental consciousness.**

Social orientation

Case I encourage upgrade grower capabilities to supply modern and export. With the specialised to those market, it will potentially increase welfare for growers and open employment opportunity, *"I am referring to 50 hectares, if 50 hectares I am ready to produce Baby French for at least 2 tons per day, it's possible at a minimum. 50 growers have a workforce of 5 people, and the workforce is also apparent, 250 people are absorbed." (I-1).* The opportunity to maintain supply is wide open, but the constraints in the limited land ownership. *"Yes, it is clear that the market continues, the market wants a price contract here because it is welfare if it is supported by adequate land"(I-1).* Case I explained that they also help members to buy products at a fair price and prevent them from unfair price offers made by middlemen. *"How many the rejects are, we will take responsibility for them, if growers send to us 100 kilos, then we count it as 100 kilos." (I-1).* For these off-grade items, the respondent makes an estimate, it is around 20%. Most of them are leaf vegetables.

With the hope of sufficient income, it will attract youth to be able to farming. Now low interest for people to be a grower. *"Why such paradigm appear because here [this industry] there is no market clarity. The market does exist, but price uncertainty makes products sometimes marketable, sometimes not. So, low interest and they do not want to take the risk." (I-1).*

Barriers in adopting Circular Economy

Growers preferred pesticide that give the fast process and that behaviour made ineffective use of pesticides cause the residue high. *"The difference between pesticide systemic and contact is that if the contact is indeed a fast process, the growers are happy to use the fastest one. That's why there are many products that contact, actually it's not a bad product, but often growers make a wrong application." (I-1).* Case I explained that they have been tried application of automatic technology but failed. *"We have tried technology for automatic irrigation. So, yes, because it was just testing, the system still needs to be repaired, automatically as a grower they do not believe that this tool can save water. It can increase productivity. So the main obstacle is if growers are aware of technology, where are the results? is it good? They want prove to convince growers. If it's not good, it's hard, you can't enter." (I-2).*

Case I explained that there is also a group dynamic that causes ineffective communication. Therefore technical guidance and support ineffective because of different interests and aims. Respondents further explained that *"Yes, think for yourself, for example, we have buyers because we search them by ourselves. Buyers, for example, we contract and build cooperation with exporters. But there is no involvement of the government." (I-1).*They did not receive proper support from the government to expand the market. To change the system, the respondent argue that an influential leader can orchestrate the same vision. *"So, many people talked about integration concept, but only a concept, they not assisting. But again, the problem is market access. Sometimes many people give the concept of integration, but growers are enough to give the concept, there is no assistance to get market access after they cultivate it, that the most needed." (I-2).*

CASE J

Internal operation in waste prevention

The company is diverting their below specifications to restaurants instead of the traditional market primarily to keep their image; there are no local markets that explicitly sell similar products unless they are a more modern traditional market. For waste products that can be recovered, the company often give them to a second party to process them into compost. They distribute their product to the market that need it. Hence, this activities reflecting **cascading orientation** and **economic optimisation**. On the other side, the source of waste in the company is the packaging, *"Here, something that is not resolved is the packaging problem, the hydroponic is packaged with plastic where it cannot be 100% recycled" (J-1).* However, even though it's challenging, the company gradually change to a different kind of plastic, *"We started it already by giving a certain level of customers, we change the packaging* *to the reusable one, recycled packaging in Indonesia is expensive" (J-1).* This reflects **environmental consciousness.**

In order to prevent waste, the company uses a cooler in their vehicle for delivery, and they are also well-aware about the perishable products easily get damaged; hence the specification of the product is often adjusted. *"Yes, included the defect, the level of tolerance, like it's impossible to be perfect like if during receiving there is one leaf broken or the leaf is become yellow-ish it still can be accepted" (J-1).* So the specification is often being more flexible. The second attempt focuses on applying the imperfect product in a specific place in the supermarket, but the problem in this process is on publication. *"it has already started, but lacks in promotion and publication are lacking" (J-1).*

Case J has set key performance indicators as one of the targets in preventing waste; they also try to form a solution to better planing supply and demand for preventing waste. *"It is about a mismatch between supply and demand at first. We will break down the problems. The incompatibility of both quality and quantity could be the reason for waste. As in quality, it might be good, but the handling process during delivery is not appropriate, and then it's about the delivery time as well" (J-1).* As the answer to this problem, the company has formed a training per division and create delivery schedule. *"Each division we will hold a training according to their functional for example packer, how to packer properly" (J-1).* Regarding waste, the company expressed the importance of regulations and precise standard operations if they want to improve their waste management. *"Yes, It is the policy first because if you don't make SOPs [standard operating procedure] or you don't make work instructions and policies, the implementation will be confusing" (J-1).* This reflects **maximisation retained value.**

Collaboration in the supply chain

Furthermore, some attempts that the company do are maintaining the communication with the breeder and adjust it with their production plan *"Yes, so far we have communicated with several breeders, for example, we have five or types of plants that we will market, now we draw them into a production plan, right from the production plan the on-farm needs has resulted" (J-1).* If there are some kinds of vegetables and fruits breeders unable to produce, they will try to replace it to another variety immediately, and the company makes sure the output would not be cut off. On the other side, when Case J face difficulty in getting their seeds, they will contact local companies *"For example, we committed there should be seeds in December, but due to crop failure of mid-production we did not get the seeds, in the end, we will try to fulfil with local production" (J-1).*

In terms of product development, Case J collaborates with its supplier specifically for the multi-site test. *"For example, they test, multi-site tests, for example, they want to introduce certain* *varieties to Indonesia, there are requirements from the department, it happens that our location is one of the sites, they usually propose to test the location" (J-1).* This test aimed for introducing a new product to the market. In addition, the company with the research and development people from its suppliers often discuss the product and market response. *"They have their agendas for each region, they will ask them, we included, for example how we produce cherry tomato and we want to see the market's response toward it, we often ask about that, but specifically for research we have not done that" (J-1).* Case J also developed a banana pack based on the ripening of the bananas by sorting five bananas from most mature to least, which allows each banana to reach the best quality for consumption for each following day and for the company to pack them in environmentally friendly carton boxes. This method was developed from company observation on customer behaviour, where customers would buy products all at once, leading to a higher chance of rot, so allocating a banana for each day would also encourage less waste.

Barriers in adopting Circular Economy

Another barrier that Case J face besides the lack of knowledge that apparently, they don't have enough materials to support the concept of Circular Economy, *"The plastic, it can't be recycled we still not find the replacement" (J-1).* In responding to the possibility to sell below specifications to the end customer, the respondent exemplified that it would be risky to their brand. *"The customers are not ready to change their mindset. They are used to perceived products should in the perfect specification, not the misshaped one" (J-1).*

In the future, the company hopes for more collaboration and partnership either from other supply chain actors in supporting this concept, *"It's hard to synchronise the interest. We have tried several times, for example, we gave vegetable waste to fertiliser companies to process it into COC, but the collaboration did not work out" (J-1).* The hardship to align the interest also followed by the needs for more government support to make it more integrated, *"There should be more practices on a smaller scale, the government should create collaboration not only in big scale" (J-1).* In addition, the company also expressed that the market should be aligned and working in harmony to adopt this circular economy properly.

CASE K

Internal operation in waste prevention

Case K has a zero-stock policy due to the limited life of *vegetables "[…] our SOP [standard operating procedure], we want no stock. So, growers have to send daily and because we send daily to modern retailers to keep freshness." (K-1).* Therefore, accurate forecasting is the key. Some vegetables cannot be kept in storage for too long because it will be risky for damage and shrinkage. Their opinion is that waste can be classified into two types: waste with intentional and unintentional remnants. Intentional waste occurs because every product sent by the farmer must go through a sorting process to choose a standard product matching the specifications of the consumer supermarket. Accidents are caused by poor process or handling, from the time of harvest, harvest packing, transportation, travel, to arrival at the supermarket.

In maintaining the supply, some growers are trained by the production team, which assists the growers in selecting seeds, plant maintenance and post-harvest methods. A coaching system would help with its quality and adjust its database to find out the availability of products. The manual sorting process must constantly be monitored. Employees are always given training on how to handle the product so that there is little waste created between the incoming goods and shipment.

Collaboration in the supply chain

With the guidance they gave to growers, it is expected that growers can send high-quality crops in accordance with retailers' specifications. *"It means we have to educate our suppliers, our growers, to send their crops according to the stage and specifications we want. We encourage them to apply good practice, and they increase their productivity and have the opportunity to enter modern markets through us, which is better for them than traditional markets. If growers understand how everything needs to be treated, there will be a little waste." (K-2).*

Case K have sales team to maintain the relationship with customers. At the beginning of every year, respondent always holds meetings with customers, in this case, represented by a team of buyers to discuss annual work program plans such as retail strategy, introduction of new products from distributors, product development that is already running, information on seasonal activities such as bazaars, bazaars vegetables, fruit market and other activities. *"The competitive advantage of our company is that we always think that consumers [modern retailers] are not tired of the innovation of developing trade models; however, consumers sometimes do not want to bother because of the many choices available. They want vegetable products as well as fast food products that can be taken home immediately." (K-3).*

The firm is aware of the environmental problems caused by plastic packaging. Through cooperation with supermarket consumers, they have begun to develop the use of environmentally friendly plastic that can decompose in 90 days, and also begun to reduce the binding rope made of plastic for products such as long beans tied with banana leaves and the packaging of bamboo such as for salacca fruit. Plastic packaging is still predominantly used by this company and follows consumer demand. Some products are distributed in bulk and only packaged in plastic baskets; some use plastic packaging with a weight agreed upon with the consumer.

Although the company still uses conventional plastic in the large proportion, admitting that it previously used styrofoam and plastics. A few years ago, retailers pointed out the dangers of Styrofoam, i.e. that it is harmful to the environment. The distributor took the initiative to replace it with plastic mica. With plastic mica, the product display still looks attractive and is environmentally friendly. *“What we can do is, we can only change conventional plastic into plastic that is easy to recycle. However, reducing the packaging depends on the retailers. Some care, some do not. If they ask us to change, we certainly do that.” (K-1).*

Barriers in adopting Circular Economy

The specifications from modern retailers in some way creating unnecessary waste, such as the process of peeling to have certain weight and looks more artistic. *“Because sometimes it’s also for the sake of art, so that it looks more artistic, it’s thrown away. Deliberately thrown away. It’s deliberately wasted, even though it is edible.” (K-1).* They also disposed waste to the landfill that indicates low awareness to the environment.

Case K was hoping that modern retailers and government collaborate in creating a campaign showing the importance of consuming vegetables and fruits and agricultural products are not uniform. *“Suppose we want a good pokcoy. Well, it will cause waste, because when there is a pokcoy that is a hole, it is rejected. Even though it turns out that the smooth Pokcoy was sprayed with pesticides, for example, the caterpillars were sprayed. So, our perspective is also influenced by the perfect specifications. For retailers, they just follow the customer, yes, they are already on display, there are no holes at all. The next day they did not want to receive the pokcoy leaves with holes in them.” (K-2).*The increasing demand for local vegetables will increase the interest of growers in growing high-quality vegetables. *“Public awareness must also support this industry; this industry is growing because we value our own products. Moreover, this is one of those influences that affect to our thoughts on the product itself.” (K-1).*

CASE L

Internal operations in waste prevention

Case L explained the importance of maintaining commitment with the customers. Not just to ensure continuity, case L established a partnership with growers to meet product specifications and prevent them from being rejected by retailers as the strategy in preventing waste. *"we have grower as partners, we assisted them, providing seeds, fertiliser and technical farming to ensure that the plant is grow like what retailers want" (L-1).* They admitted they still experience supply disruptions because of diseases that result in crop failure.

"Although I have collaborated and have a partnership with growers, I still have to face the risk of having crop failure" (L-1).

Collaboration in the supply chain

Building collaboration with growers is formed in contract farming arrangements, starting from nurseries, planting methods, harvesting, and selling all produce grades. Case L keep updating the knowledge of cultivation technique and acquire information from many sources and transfer it to partners. They realise the importance of equipping partners with the knowledge needed in plant maintenance, including the use of organic waste for biological fertilisers bio-fertiliser. Case L understands the partners has low awareness in processing waste. The use of environmentally friendly materials is only for the use of cardboard boxes and plastic baskets, this is only for practical reasons as requested by customers.

To ensure availability and food safety, modern retailers routinely visit and evaluate the performance of case L in delivering the orders. Retailers regularly check how the product is handled at the distributor's warehouse, examine the harvesting process in the field, and check the safe use of pesticides by the target growers to measure the chemical content and pesticide residues of the products. *"Retailers have an independent audit team, so later we will have a term for example, when planting melons, what kind of pesticide should be monitored, the insecticide level, chemical content, soil residue, what fertilisers were used" (L-1).* This reflects **leakage minimisation.**

Technology adoption

Different views to digital technology adoption, case L, admitted that social media has many advantages for coordinating and exchanging information between partners and customers. The respondent illustrated, *"for melons we have to be intense, intense almost every 2 days, we have to monitor. We have a group chat. I don't have to go to location, later from the grower, the report is like this. Like today's report, today's date is at 2:42 p.m. already reported, the progress, what will we do later if there are problems usually they photographed, sir, how about this disease, like that. We solved the problems together."* Case L also use digital technology to improving knowledge through the Internet, and knowledge sharing between networks, any information such as the technology of farming, issues and market trends, they try to adapt to what the market needs. Applying digital technology reflects **waste elimination** and **economic optimisation.**

CASE M

Internal operations in waste prevention

Case M is aware that they do not always distribute product of the highest quality. In response to this, the respondent stated, *"That is why we coordinate the growers; whether I like it or not, I have to do selection; I just want to accept something like this because retailers require specifications like this" (M-1).* The guidance provided to growers regarding standard operating procedures enables them to maintain the same level of quality as their customers request. The respondent ensures that growers are always supervised throughout the cultivation process to prevent them from growing the plant improperly, *"We teach them [growers] that way. If you do not want this to happen, use this fertiliser in along with this method" (M-1).*

In respond to possibility sold the imperfect products to prevent them being unnecessarily thrown away, case M explained. *"There is one, something like that in modern retailer. But for middle and low economic class. Because it is their second market, usually because the product is purchase in large quantity. So there are potatoes that just misshaped like that" (M-1).*

There are several reasons for waste occurrence, which is the focus for the company to finally observe how to process waste often caused and continue to make improvements. Respondent explained, *"Yes, there are some food waste caused by handling process. Fruits and vegetables are perishable product and very susceptible, if they're being handled poorly they will end up damaged. But it is not a lot. We have long experience, we learn" (M-1).* The respondent continued that the customers will complaint if there is products that does not pass the specification *"It will be monitored later. It must be the customers that complaint, they often take a photo of it and send out to us after that they told them to make sure it will not happen again" (M-1).*

Collaboration in the supply chain

Case M stated that it is critical to maintain a commitment to modern markets and comply with their request. As they also distribute various commodities, they have an extensive network and source some products from another province because sometimes supply is disrupted by bad weather affected products quality.*"In this case, the buyer or modern retailer, besides set specifications for the products, wants to know where we get our products and our ability to meet their needs. They also control the way it is packaged and determined weight in one package. Maybe eggplant is packaged in 300 grams in Hero or another modern retailer, Lotte they want 500 grams. We follow their specs. Every modern retailer has their specifications" (M-1).*

The respondent explained the importance to keep updating every information with the customers and growers so as aligning. *"It diverse, leaf vegetables, it depends on the customers' demand, many things have to manage, we need to keep up to date" (M-1).* The respondent mentioned how vital for them to have a contract with the customers, contract help them to be clear with the amount of commodity they need to supply. The contract as based on them to communicate with growers and to deal with price. *"Once per year we contract. For more specific, the price is being updated once per week alongside the purchase order Sometimes, there is some revision midst of the distribution process, mostly about additional product" (M-1).*

Case M explained that they has no power to decide the packaging, although they aware the impact of styrofoam but has no choice but to follow the specifications that modern retailers want. In this case there no such win-win solution, which show low concern to environmental issue in agriculture business. *"I know. But we use styrofoam. It has environmental impact but my duty is just follow their want. They are the one that have rules" (M-1).*

Technology adoption

Furthermore, the respondent personally expressed the desire to be more advanced in terms of technology adoption, the company realised the benefits of technology for their growth and collaborated. *"It is really needed, but for export there is my packing house, I collaborate with my friends in Jakarta, they already use machine. Use cold storge, conveyor, cleaning machine. Now, not everything has to be with machine. So have do manual. To clean off it can't be done with machine but maybe someday I will invest" (M-1).*

CASE N

Collaboration in the supply chain

Case N suggest the importance of coordination with digital technology and have a supportive network to ensure continuity of supply. With continuity of supply, the firm can create delivery scheduling. The company explained that both quantity and quality are equally important for retailers. Since the retailers have no day off in its operation they have to continue supply is essential yet the quality also something that they set as the priority, *"Yes continuity also quality, regarding quality it depends on the seasons, the most important thing that during the hard season the result is not that bad" (N-1).* In addition, the company also mentioned that even when the appearance slightly downgraded during a difficult season, as long as we communicate to the customers will understand. The respondent stating that *"we receive PO [purchase order] before day one or day two we prepared, then we communicate to the growers During the dry season, there is no rainfall at all, but we do have some rainfed land. Then production begins to decline" (N-1).* The company specifically stated that they typically receive orders D-1 or D-2. Case N confronting some obstacles along the way, most notably in terms of product supply during certain seasons: *"Not only during the dry season, but also during the rainy season, when rainfall occurs during the day and night, it affects how crops grow, but* *many of them also decay" (N-1).* Having understood that the agricultural produce affected by weather, Case N explained that having a network with other growers in areas with low rainfall is beneficial. The company stated that they must secure at least 50% of the supply.

Case N see collaboration with other parties as an attempt for them to develop themselves and increase their competitive advantage, *"We mostly do it in retail, we go there not alone, there might be competing with others, there must be other suppliers in the retail. They are already there, they may have new items that are in high demand in the retail, so our development in terms of a commodity is increasing" (N-1).* Observing the market trend, the company learn to develop their product variety by seeing the retailers and other distributors. Internally, Case N is open when it comes to the learning process with various parties as the company responded regarding the role of interns in the company as *"like from the vocational high school or universities they have their fields, there are cultivation, post-harvest, they can learn what we are doing. We exchanged knowledge" (N-1).* Most of the interns are fulfilled with theory but lacking with real work experience. The exchange of knowledge between them and interns are helping for the company development.

CASE O

Internal operation in waste prevention

Case O preventing waste by having an accurate demand forecast. *“After we received a purchase order, we then make an MoU following that we communicate to our partner. For regular customers, we know what they want, so we provide based on their order” (O-1).* They also train their employees. There are sorting process that there is some waste that the company generated. The leaves, as a form of waste, usually get trimmed and processed further. *"There are some that we gave to the community nearby to be processed to be composted. There are some that fish farmer collects" (O-1).* Community near the warehouse are the ones that collected those waste, but the company admittedly, there is waste that gets thrown away without any process.

Collaboration in the supply chain

The company revealed that strong partnership with their growers is one of the critical factors in how they maintain their continuity, *"products from our partner farm is 70-80%, the rest we buy it from the market. We do have partners, supervision, there's continually visit, auditor visit the growers and give counselling if there's some items that we can't grow by ourselves, we should import […] the key is trusted, partner" (O-1).* Besides a partnership with growers, the relationship with the customer plays an essential role in the company's development. Case O have to follow customers requirements to keep their commitment in maintaining a trusted source of material. *"Several times we do some test, micro test every month, E-coli, Listeria,* *Salmonella, then later we will test pesticide residues, once a year there is also a water test that we use" (O-1).*

Whilst internal collaboration is focused on the continuity of the supply, and the external is more on creating better product development as the company stated that *"We're really active, for example, if a consumer has a global standard so internationally, they have a standard too, for example, product specification, so we follow that" (O-1).* The global standard of product specification form customer that the company has to fulfil, help them develop a product together as for example, if there is a certain product that consumers want to sell, then Case O will propose some products as trial. *"That's from the product side. For research, we send supply, diced potatoes, if we do not use sodium, it will be easier to turn brown, so we don't use it" (O-1).* Case O specifically explained that they would not close the possibility that they will do it individually or with customer for research purpose.

The learning process that the company acquired from human resource, leadership, and value passed through from the company leader, helping them grow, and many collaborations have been established with the company abroad. *"Everywhere our team always have reviewed, I learn from the owner. To be a pioneer is not easy. Back then, our leader collaborated with a company from the Netherlands. From that collaboration, I learn. They suggest how to cut vegetables properly, what machinery should be use" (O-1).* Case O stated that they rely on learning by doing as well as learning from the customer and networking. The latter was established by a form of a joint venture as the company specifically said that *"We got a chance to work with a company from the Netherlands as a sister company, a joint venture then we develop our product by selling not only vegetables but also meat, it becomes bigger and bigger" (O-1).* Furthermore, when it comes to the partnership locally, the company has been doing some labs regarding product development and crops.

Being hit by a pandemic makes case O think creatively in expanding the market from B to B to B to C. They are taking advantage of the market to end customers. They collaborate with online market providers, and they get much help in selling online. *"We collaborate with online service providers in selling our products, for example with Blibli, Go fresh, Shopee some are sent to consumers directly, some are to their distribution centre, they help us make profiling the target market, how many of them close order, how many are not. It is useful for us" (O-1).*

Technology adoption

In terms of technology adoption, Case O is orientated to international standard, as they often communicate with the customer. They use this as an opportunity to develop more advanced technology. *"About technology, we don't have any choice but to follow our customers with a global brand that direct us to use the machine and procedures. We usually have some session* *with customer with the international standard then they will share to us. For example, cleaning machine, ozone filter. But technology does not only use the machine, because if talking about HACCP the procedure needs to be like a system from upstream to downstream, facilities and human resources" (O-1).* Another form of technology that company use to set and create temperature is the air conditioner, and they rely so much on it as they stated that *"For temperature, we must create it with air conditioner, we use blower then rinse it, for packing room is 10 degree, to maintain the freshness of the vegetables we have another option but to use the air conditioner" (O-1).*

Barriers in adopting Circular Economy

Case O's perspective on the circular economy concept is that the amount of waste still lacks people participation and knowledge. As the company itself does not have adequate regarding the concept, they also stated, *"Logically, it could be adopted here, but the problem is that there's still much waste that none want to pick up, before we have collaborated with a zoo, they took it, but we gave it for free" (O-1).* The lack of parties involved also becomes why the waste is still considered piled up because the previous party such as the zoo, only takes the waste once a week. Furthermore, Case O revealed that in order for this concept to work out, they have to prepare more things. *"There should be new invention such as the chopper machine for waste. So it can process a compost, then we also need people who have ideas and technology" (O-1).* The company mentioned that currently, they lack facility and human resources with the capability to develop new ideas regarding this concept.

The company's concern also lay on how lack of support in other parties in adopting this concept, besides none is willing to accommodate the amount of waste constantly the people in this field also not giving expected contribution. *"There is waste every day, and it is not that bad, it is only getting trimmed, it will be better if there's people who want to accommodate it then chop it. I told the students in university several times to create chopper machine or making compost, we will give it [waste] for free, but the determination is low, many also the bachelor of agriculture not working on this field" (O-1).* The lack of passion of people in this field become something that the company really regretful. *"We don't have the technology" (O-1),* the last thing that Case O mentioned about the barriers in adopting CE is the lack of technology they have.

CASE P

Internal operations in waste prevention

The standard operating procedure (SOP) was claimed as the primary waste prevention due to economic performance. The respondent described waste controlling is part of the key performance indicator (KPI), *"we have the KPI for breakage items cannot exceed from 0.6%*

from sales." (P-2). Case P provided a chiller display that prolongs shelf life, using ice cubes in some of the display and a manual spray. The respondent explained that they record all of these food losses and food waste in a system. *"All our losses are recorded in the system we use and are overseen by many people." (P-2).* They also train employees who involved in fresh products, illustrated by the respondent. *"We are training the team. In fact, we have a quality and hygiene team that independently monitors its work methodology, product handling, food handling, and even the display implementation rules are monitored by internal and external quality hygiene." (P-1).* The respondent elucidated the company continues to evaluate, *"the action we take is to do an in-depth analysis, why there are so many losses. Is it wrong in the number of orders or wrong handling in the display or because of poor storage?" (P-3).*

The company explained that there are not many recoveries made for repurposing into processed food. *"If we do not make this […], for example, this one is half broken. We make salad from the good half." (P-1).* It is not only salad they make. *"Juice, salad, juice. Or we make food here. But it is only from the good ones, the bad ones we still discard" (P-2).* The respondent gave an example of other derivative products, *"we open the skin into sliced fruit, make banana cake, banana juice." (P-1).* For vegetables have limited recovery step; they usually discarded when it looks not suitable for display. However, other fresh products have stages in processing food that becomes derivative products, reflecting **economic optimisation** and **cascades orientation**. One of waste prevention is by having accurate forecast demand to avoid excess order. The respondent explained, *"Excess orders without looking properly at average sales will cause large food losses or breakages." (P-3).*

Case P does not have waste management. They are not donating because of sensitive issue and concern with the reputation. To avoid misuse of food, all the breakage discarded and takes the waste to a landfill. The informant explained that *"Food waste is a sensitive issue. Our company is concerned about the food safety issue and the continuity of the business. dealing with food waste […] We chop up the products, even using chemical to make sure anyone cannot use it." (P-1).*

Collaboration in the supply chain

Case P made arrangements periodically and visiting suppliers to communicate, observe the product quality and the ability of suppliers to continue delivering commodities regulation of chemicals used in the planting process. *"It's regulated because we have an internal and external hygiene audit" (P-1).* The audit included cleanliness, temperature, display bar and ordering equipment checks. Further, the respondent described how details the procedure in regulating the fresh products and asking their supplier to follow their regulation, *"we have SOPs on this. If indeed the product has to be refrigerated, then it must be sent using a cooler, if the product is indeed at room temperature, then there is no need to send it by using a refrigerated truck. Depending on the type of products sent." (P-3).*

In product development, they communicate together with the sales development and suppliers. *"Two sides. It could be from us; it could be from the supplier. Even the idea from the supplier is good, and even the supplier is rich with innovation. Such as, the factory for the innovation of packaging, bottles, all kinds. Sometimes our customers sometimes said, too big, then we can change them to smaller or something. We have a sales development name. There is a sales development. Sales Development aside from looking for new ideas, they also make innovations that suit to customers. So, two sides. So sometimes the sales manager also does a survey to customers asking them what you want?" (P-1).*

Technology adoption

Case P uses no sophisticated technology. They rely on showcases chiller and rely more on product knowledge to treat products to extend product life. As for the investment orientation towards technology will depend on how company policies are; currently, there is not yet because it is considered sufficient, as alluded by the respondent, *"So far the technology is currently quite efficient. We use a showcase chiller. But, investment in advanced technology depends on company regulations" (P-1).*

Social orientation

The respondent explained that the company does not cooperate with any party to donate food. Their concern with food safety of donates food could cause adverse effects on health to the community. *"No, because later if the person is sick, they will ask where the food come from; it prevents things like that. Although some food is still edible." (P-2).* As stated by informant P-1, *"We have been working with a third party to distribute food waste, but because they misuse it, we no longer trust them; so we have stopped that programme." (P-1).* Reason to protect the brand and business reputation are is vital to them.

Barriers in adopting Circular Economy

The respondent explained that sell below specifications to the customers would be inapplicable because of the preference of consumers for cheap but perfect products and their low environmental awareness. *"Whether it can be possible or not. In my opinion, it is not easy. Our consumers want the perfect product but at low prices, unlike in the West country where they really care about Earth. Extraordinary, but it will not take a short time to implement it; it* *may take ten years maybe." (P-1).* A concept such as recycled packaging and wonky fruits can be tough to be implemented.

Companies have difficulty obtaining suitable substitute material, so they have not yet switched from using styrofoam. *"Not yet, because we have not been able to get the substitute for it. That's the problem."* Respondent P-1 explained that they need to measure the change explained that they need to measure the changes made at the cost they charge. *"Once again, we are commercial, and we count everything. The products we buy we count, even the taxes we pay to the government, actually bear the customers. Packaging is following the function of the product, and for example, the product must use a cup, dry products we used to use styrofoam. But now we are starting to turn to food-grade paper bags or mica plastic. Because not all of them cannot be replaced, now it's like a bamboo box, right? No one can provide thousands even if we use leaves. Who can provide the whole of Indonesia? We follow some things, but the flow is according to the function of the product." (P-1).*

Case P cannot make donations to the community needed or sell products to employees with reasons of concern to misuse. The waste that is thrown away is also lost because of the issue of trust in using animal feed and compost. Respondent P-1 explained, *"Even earlier, some were selling cheaply, we really don't recommend it. It could be a staff buying. Because those who buy employees first, maybe only 20% of the customers, but they deliberately produce more, so the price is more like buy one get one free at 9 pm. So, there will be a question, how come the sales that buy one get one free are a lot more than the regular ones? That is not good for business." (P-1).*

CASE Q

Internal operations in waste prevention

Then respondent explained that the reasons for food waste occurrence is handling. *"Usually, it is about the handling issue if the handling-loading is not done properly or the display is arranged carelessly these can be the reasons why products are damaged" (Q-1).* Additionally, the way employees create display arrangements will determine whether the product can be damaged or not. Poor arrangement and high stacking are the main reasons. *"Perhaps when they are in the storage, being arranged, they are allowed to collide with each other so there are a lot of blisters. It depends on the FIFO. If it works, then less waste" (Q-1).* Talking about consumer behaviour, the respondent explained that. *"When consumers select products, they tend to ruffle them. Some put them back in a proper arrangement, but others do not. So, they become damaged. So there is our staff who rearrange the products every hour. So sometimes the things get messy, there must be someone around to sort them" (Q-1).*

Furthermore, the respondent explains that some unsold or damaged products in the store is able to be exchanged for fresh products from the suppliers, provided that they follow some requirements. It is mentioned that the company has made deals with the supplier, although the respondent concluded it is not a form of consignment. *"It is not all items. Maybe it is only bananas, sweet potatoes, onions that can be returned to our suppliers. The rest are not returnable" (Q-1).*

Collaboration in the supply chain

The respondent stated that they receive lots of support from their headquarters from Japan. *"Every month they will come to visit and discuss several important factors regarding business activity, and there is also product training and QC training, hygiene quality learning, classes for upgrading handling skills" (Q-1).* In this training, they learn about technical details and grow personally as individuals with responsibility and integrity.

To maintain continuity, case Q establishes contracts with suppliers; even though they do not bind all parties, they ensure to arrange them concerning the products that most likely will be hard to produce in certain situations. *"Most of our crop contract are on fruits. Most of them are able to supply their product continuously" (Q-1).* The respondent concluded that the main reason for having this crop contract is to maintain stock continuity. The respondent added that they only sign a contract for exotic vegetables such as yellow paprika, butternut squash, pumpkin. Meetings with the supplier are conducted every two to three times a year. *"The meeting is in the HO, but sometimes suppliers invite us; it is similar to a study tour. it is a crucial way to improve the performance of both parties" (Q-1).* This intends to make the company care more about the grower's situation and products that they grow.

The respondent stated that the government has an essential role in helping the whole industry develop as they hold immense power to make regulations and oversee every actor in the supply chain to keep running according to the directions they created. In this case, the respondent revealed that the government often undertake inspections of the store to do the checking, which entails each product and uses of the pesticide. *"Mainly the inspection is about expiring products, food security and hygiene."*

Social orientation

Case Q used to have a programme with local residents to manage waste. *"Before we had a programme with local people, who suggested the waste can be used as animal feed. It was running but eventually had to be stopped" (Q-1).* The company also provide training and workshop for the employees. *"In addition to product training, there is also QC training, learning on the quality of hygiene, classes for upgrading, increasing salaries, there are special classes, so they are taught calculating formulas. There is also social awareness training which is* *practised at home affairs to form personal and responsible. Suppose the environmental problem is more to the upper people. Later the top people will train us. Some are indifferent, but people who want to listen to will find this training useful" (Q-1).*

Barriers in adopting Circular Economy

Unlike other retailers in general, the respondent clarified that the company is limited in making derivative products. *"In some modern retailers, there are many derivative products, but here we are limited making such products, only for fruits" (Q-1).* The respondent explained that the only way the company handles waste is to discard the product immediately, but they make sure some steps are gone through before the waste is completely discarded. The company has not yet decided to switch to substitute material because they struggle to find appropriate material that will sufficiently protect their product. *"We try to look at the alternative, such as plastics from corn-based, but I whether the material is available or not, I don't know yet, is not easy, if we use paper for the packaging it will easily be ripped off" (Q-1).*

The company has no collaboration with parties to donate their food waste product. Their current solution on waste is to destroy it all, which they believe is for safety purposes. *"Yes, it will be destroyed immediately. In fact, there was once such discourse from employees about why the company does not donate it to a charity or even sell it to employees at half the price, but in the end, this was not implemented" (Q-1).* The respondent explained that the reason for this decision was that their headquarters in Japan is strict about hygiene and protection.

CASE R

Internal operations for waste prevention

The company determines the lifespan of produces mainly from physical appearance, as they highly value the quality of display, which relates to their definition of food waste as *"products that is edible but no longer worth displaying" (R-1).* Case R explained that food waste could occur in many processes, especially the delivery process, where products can quickly become blistered and damaged. *"Even with small friction or being piled up, they are very fragile, so there is an immediate potential for damage" (R-1).* A quality control process is followed right after products arrive at the store. These will be sorted taking account of the company's specification; the products that do not pass will be rejected and returned to the suppliers. *"From there, they enter the display area, after which they're put on display; there's also sorting here. The sorter is the customer. The products that the customer does not take are most likely to be damaged" (R-1).*

The respondent suggested that the average amount of food waste in his company is approximately 5%. *"Is about 5 per cent. It comes from the total amount of damaged products every month that we have calculated. This includes due to consumer behaviours, for instance* *when they try some fruit to only then eat half of it and put the rest back on display" (R-1).* Another factor is how they aim to sort out the fruits or vegetables but end up spoiling or dropping them, or it can also be when children are brought into the store, and they play with the fruits and vegetables, causing damage to the products.

In addition, products that are still edible and safe for consumption are bought by their restaurant. *"So those restaurants [...] They do not buy the product elsewhere; they buy it from us" (R-1).* Usually, the restaurant will come to them and buy those products, which the respondents explained as a transfer between departments. It is further elaborated that breakage in the store is done once a day after being scale and witnessed by security to prevent fraud.

Regarding human resources, the respondent explained that the company provides proper guidance and training to their employees, which helps prevent waste by limiting human error. *"Yes, we have complete training for our employees. For new employees, we give them product knowledge and handling training" (R-1).*

Collaboration in the supply chain for Circular Economy

Case R is trying their best to maintain the continuity of supplied product from its suppliers. Respondent mentioned that they have 12 suppliers working with them and believe that the most crucial part of their collaboration is the suppliers' ability to provide all products in the long run. *"First of all, it is their continuity" (R-1).* Furthermore, he explained that the company has its own specifications regarding the product and what is essential for them to is the continuity of available products and certainty from the supplier. *"Yes, for specifications, we have the agreement rules" (R-1).*

Case R expressed the importance of building and maintaining good relationships with suppliers and creating a work programme. *"Yes, one of them is a work programme. For a year, it has been running. If we talk about vendors, I think it will be about product development. We communicate about the sales, trend, and payment system […] So, this company provides great opportunities for its suppliers to compete […] What do they have. Come on, make a programme. So, we give flexibility to the suppliers if they want to make product development, such as ready to eat package" (R-1).*

Barriers in adopting Circular Economy

Although not using natural resources directly, case R depends on natural products. *"We are not using direct natural resources, but what we sell are products from natural resources" (R-1).* As explained by the respondent, the natural factor often creates problem in the procurement process, for example, the seasonal factor. The seasonal factor is one factor that can be obstacles for suppliers to supply high-quality products. Case R explained that specification system. *"Our people used to the perfect product specifications. We adjust to being like them. This is the good standard, and then, in the end, all modern retail has the same mindset; that a good product is flawless, big, straight, basically it has to be perfect. However, this brings problems for growers. If we buy all grades, it will be cheaper, but then we have an obstacle because we have to follow specifications book" (R-1).*

CASE S

Internal operations in waste prevention

When vegetables and fruits are near the end of their life, case S processed them. Especially to the products that potentially be used for derivative products, the respondent stated that some kinds of vegetables are able to be recovered such as cabbage, cucumber or carrot and turns them into ready to eat, such as salad and pickle, *"those types of vegetables that probably we can still utilise, they are stages, we make one step before final disposal […] they can be made into a salad or become pickles. Yet, it must also be sold in the same day, cannot be more than that, same as the fruits have some steps before they completely become waste" (S-1).* Hence, this demonstrated **maximisation of retained value**.

Collaboration in the supply chain

The two most important factors for case S in selecting their suppliers are continuity and quality, to set delivery scheduling, so they must have many suppliers and should reliable, *"For us, surely it is continuity; secondly, quality. The price will follow the quality. The quality is important because we need to compete with other retailers" (S-1).* This reflects **maximisation retained value.** Unlike when products can be obtained easier, in which a more stringent specification is applied, tolerance to an extent will be held for product specifications when case S experience shortage due to weather disturbance. The informant explained they had good communication with their suppliers; they often visit the suppliers. During the visitation, case S also met several parties introduced by vendors; growers were also included. For product development, they communicate together. *"we work together with the supplier, exchange ideas how to innovate the product, like the current trend healthy lifestyle, we talked with suppliers how we can serve our consumers" (S-1).*

Case S explained that they did not establish any contract farming with suppliers or growers. Besides the contract farming is not a common practice, the nature of the business is transactional, non-consignment, and they only take the perfect specifications, so it will be risky for case S. *"For now, we never had it [contract farming]. What we have ever done before is a crop pattern contract. For example, the vendor has a group of growers. So, next, there will be* *tomatoes for 5 or 10 tonnes. Then we negotiate with them about the price and specification with a contract, ok I will take 5 tonnes like that. I think it's only like that" (S-1).*

Although the respondent aware that plastic is a global issue, they did not deny that they still use plastic to wrap certain vegetables and provide the plastic for scale. *"For scaling the product that we sold in bulk, it has to use plastic. If not, then there will is the possibility of misuse from customers if they bring their plastic bags from home, such as how they will put the products into them" (S-1).* The respondent also added that the use of plastic for vegetable wrapping is chosen because if they are not wrapped in that way, they will be damaged more easily. The respondent added that they are no longer use styrofoam and replace them with mica that can be perceived mor environmentally friendly, *"Inside the packaging, we no longer use styrofoam. We already use mica, so it is already more environmentally friendly […] other retailers may still use it [styrofoam]" (S-1).* This reflects **environmental consciousness.**

For the future, the respondent has looked at the possibility of material substitutes in the stores. The company is still using sticky tape to wrap leaf vegetables, and the respondent believes that there are other materials they could use, such as a banana leaf. *"In the future, I have thoughts about the leafy vegetables, for example, they could be wrapped with banana leaf instead of sticky tape, but we need to look into the banana leaf availability" (S-1).* One thing that is still a concern for the company is whether a party can provide banana leaf with adequate continuity and amounts needed.

In supporting energy efficiency, case S adapted its opening hours. According to the respondent, not all company outlets have shopping activities at 8 am. So, the company also adjusts the opening hours of their stores with shopping activities based on location and consumers' behaviour. For example, if it's located in a shopping centre block that starts to open for the public at 10 am, then the company will follow by also opening its store at 10am. This strategy carried out by the company has succeeded in providing savings on electricity usage.

Social orientation

The firm has yet to form any collaboration with other parties regarding the repurpose food for donation. The non-existent donation is due to the risk of misuse by some people. The respondent explained that they do not want to take a risk with it, and in the end, they believe it is safer to manage the waste by themselves. *"I do not know if it is in the store. But I'm worried it will be done wrongly by some parties. So, if there is a damaged product, we just destroy it all" (S-1).* One example of the case they are worried about happening is when some people then resell the waste and cause health problems.

Barrier to adopting Circular Economy

Specifications appear the main barriers in adopting CE. Consumers who shop at retail are looking for the perfect products—related to the positioning of the modern retailers with the traditional markets, the consumer also as a barrier due demanding the perfect specifications. *"There are usually two grades that we accept, A and B" (S-1).* The respondent explained the requirements for retail is that the product has to be in its best shape, i.e. flawless because appearance is crucial in modern retail. The grading system is applied as a form of strategy by each retailer *"Yes, it is a must [the specification] because every retailer has its strength"(S-1).*

CASE T

Internal operation in waste prevention

Case T explained by understanding the cause of waste enable them to continue evaluating because it related to the performance. They admitted that one of the key performance indicators is reducing unsold products. Respondents T-2 explained, *"Food waste is unsold product because they are damaged. Causes are varied. It depends on the handling, consumers behaviour, display management, technical problems such as electricity blackout that reduce freshness […] We have KPI [key performance indicator] that measure how much the breakage." (T-2).* Case T has set out the maximum tolerance of waste based on the revenue and size of the store. Respondent T-1 stated the total value of waste should not surpass 7% of the revenue in total but T-2 respondent have a different answer "*We have target 8% from turnover.*" *(T-2).* Followed by those statements of respondents T-*3 "Tolerance rate is diverse. As for me, in my store, here only 7% in total but each product can't be more than 10%. We keep that number does not exceed from that." (T-3).*

Respondent T-3 explained how food waste becomes one of their major concern, the loss and disadvantage of food waste affect not only their profit but also their impact on the environment. Apart from the selection of appropriate product specifications, other waste prevention measures include proper handling, product arrangement, and the use of refrigerated displays. *"So that's why the handling during receiving process has to be very tight." (T-3).* Respondent T-1 sharing the same concern, *"When we first receive our products, if we really do not have good handling, if we do not focus, it will occur loss on us." (T-1).* Respondent T-1 mentioned the importance of keeping the appropriate temperature in their cold storage and display, even they spray manually to keep the freshness of vegetables and fruits. *"The cool storage has a function to protect fruits and vegetables of significant temperature change it also prolong fruits and vegetables We have treatment, a spraying system it will be secured. 9 am, 1 pm, 5 pm and 7 pm. For vegetables we crisping-in, we make them fresh again so in the display there is specific place, there we put ice cubes and water, we dip there. Every one hour, we spray vegetables with cold water." (T-1).* Thus, the manifestation of principle **maximisation of retained value.**

Case T understands the value of maintaining and improving while continually evaluating, as evidenced by all respondents agree on how the company has provided various training for employees and audit, as respondent T-4 stated. *"We have several training, for training especially to reduce it [waste], there is training in handling. Food safety and the recent one is a new national programme, FFC, fresh for the customer, which means that the products sold must be fresh. We have an internal audit team, and they appraise the performance also food safety." (T-4).*

In term of processing waste, respondent T-2 stated, *"If the product already accepted into the store and there is damage generally it would be BS or broken stock. Our administration term for this is broken stock. Then after 6 pm, the limit is 6 pm until 10 pm. If it is unsold, then it will be destroyed." (T-2).* All respondent mentioned that the unsold product would be end up in breakage as respondent T-1 explained in detail*, "Yes, it is weighted, it is recorded, then it will be input to product damaged of store losses. We destroyed, do not let the shape still be seen. Like watermelon or apples, when rotten, we cut into pieces to not be consumed. It is peril." (T-1).*

Collaboration in supply chain

In response to sustainable raw material, respondent T-3 explained that the company still depends on plastic usage, primarily for products sold in bulk, *"Still use plastic for customers and only plastic bulk items. We use plastic roll, and then we sealed it, it is given labelled scales. Management has yet to give the facility for packaging like that [recycle bag]. But for plastic bags, some of our store not using plastic bags anymore as follow the government regulation that prohibits modern retail from using a plastic bag. It will be easier for us as retail. For me, I would prefer it will be prohibited. The plastics factory should be closed and told to produce a replacement. Then we can stop using plastics." (T-3).*

Respondent T-2 added, *"It is already a regulation. It has been running for two months. We do not use any plastic bag anymore. It is zero per cent. In hope, the consumer will bring their own shopping back, or we pack it with cardboard that can reused, but there is one loophole that we still do not know the solution is plastic for fruits, because we do not know what to use ideally." (T-2).* As alternatives, this cardboard offers another material besides plastic for consumers to carry their product. Respondent T-2 explained, *"For now, we have not found a proper solution for that, but we have begun to try to reduce styrofoam on displays by using plastic trays." (T-2).* This reflects **environmental consciousness.**

Appendix F Published Papers

Journal of Business Research 142 (2022) 17–31

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

A circular capability framework to address food waste and losses in the agri-food supply chain: The antecedents, principles and outcomes of circular economy

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ARTICLE INFO

Keywords:
Circular economy
Food loss
Food waste
Natural resource based view
SMEs

ABSTRACT

Food loss and food waste (FLW) within agri-food supply chains in the developing world remains a perennial problem. This is partly due to the lack of knowledge on how business operations within supply chains contribute towards the FLW issue, particularly in the case of small and medium-sized enterprises (SMEs). Circular Economy (CE) has been heralded as an appropriate pathway for businesses towards reduction of FLW, however, the practical realities of how the CE can be best employed remains unclear. This paper fills this knowledge gap by studying growers, distributors and retailers in the agri-food supply chain, in order to develop a Circular Capability Framework. The findings generate unique insights into FLW understandings, causes and mitigation strategies to provide a detailed, developing world relevant food waste hierarchy. The novel framework we propose can aid participation in the CE by conceptualising CE antecedents as business capability pathways, set out as eight propositions.

Please find the full text

DOI: https://doi.org/10.1016/j.jbusres.2021.12.020

Circular Economy Adoption in the Upstream Agri-food Supply Chain: Understanding the Implications of the Two Theoretical Lenses

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Abstract

This paper investigates the adoption of Circular Economy (CE) in the upstream agri-food supply chain, employing a qualitative multiple case study research. The findings suggest that the CE emerges in the upstream agri-food supply chain and the early stage of development. In particular, these include (1) the elimination of pollution and waste start to be implemented due to the realization of cost-saving initiatives, (2) the need for collaboration in the supply chain and with external stakeholders, (3) technology adoption, in particular digital technology, is beneficial to reduce asymmetric information, and (4) social orientation in the form of diverting crops to secondary markets, donations, and involvement of the local community. Some of the advantages from exploiting interfirm collaboration include the creation of adding value in securing raw materials and acquiring knowledge through asset specificity. Uncertainty, due to the absence of a contract with the customers that can protect the growers, influences ineffective waste elimination. This paper contributes to the literature on CE in the upstream agri-food supply chain. Future research is needed to investigate the CE involving downstream agri-food supply chain. The practical implication for the upstream supply chain actors is in terms of making the supply chain more circular.

Keywords
Agri-food, Circular Economy, Natural resource-based view, Transaction cost economics, Upstream supply chain

1. Introduction
The agricultural sector uses enormous amount of natural resources, causes land degradation and freshwater depletion (Kummu et al. 2012), producing more food than is needed (Beausang et al. 2017). However, many people still face hunger. There are also natural disasters causing crop yields to be disrupted, and food loss and waste, which is a global issue, must be addressed (FAO 2019). Circular Economy (CE) has been introduced as the regenerative system, replacing the current linear system. With limited resources and a growing population, the linear economy will no longer be able to sustain this 'take-make-dispose' (EMF 2013) system which is problematic in all areas: economic, social and environmental. Circular economy has emerged as a new industrial paradigm and a solution to the negative externalities exposed by the linear economy (Murray et al. 2015). Ghisellini et al. (2016) explained that CE is the new paradigm to achieve sustainability. Geissdoerfer et al. (2018) highlighted CE as an economic system that minimizes resource input into waste, emissions, and energy leakage out of the system, which is expected to mitigate negative impacts without jeopardizing growth and prosperity.

2. Literature Review

2.1 Circular Economy in the agri-food supply chain

Since it has been widely introduced, CE has received attention from academia. The previous literature has provided empirical studies of CE in the agri-food supply chain: Paggoto and Halog (2016) researched eco-efficiency performance in the Australian agri-food systems through the use of input-output-oriented approaches; Teigiserova et al. (2020) proposed a framework using a waste hierarchy of food surplus and waste in a closed loop in the whole supply chain; research in the context of Indonesia, using Industry 4.0 technologies in waste management to achieve sustainable goals (Fatimah et al. 2020); the utilization of waste into energy (Ingrao et al. 2018); Maina et al. (2017) designed a roadmap towards a circular and sustainable bioeconomy through waste valorization; Beltran et al. (2021) proposed a mechanism to transition to the circular bioeconomy via sociotechnical configurations; Jurgilevich et al. (2016) outlined CE in the food system consisting of reducing the amount of waste, reuse of food, utilization of by-products and nutrient recycling. We can summarize the key aspects of CE in the agri-food presented by these papers as the minimal use of natural resources, environmentally friendly production design, prevention of waste, and using waste to become nutrients. A considerable number of researches have observed the adoption of CE practices; however, research on CE is still needed to explore to what extent CE has been adopted in the context of developing countries. In this research we use the CE principles which includes cascades orientation, maximization of retained value, leakage minimization, economic optimization, environmental consciousness, and waste elimination (Ripanti and Tjahjono 2019) to assess the adoption of CE.

2.2 Natural resource-based view

A study of sustainable operations has used NRBV (Miemczyk et al. 2016). The key strategic capabilities are pollution prevention, product stewardship, clean technology, and base of the pyramid (Hart 1997; Hart and Dowell 2011). Firms' payoff in implementing NRBV is a competitive advantage. Pollution prevention aims at the prevention of waste and emissions from the source of production. Product stewardship extends the scope of pollution prevention to include the entire product processes of the company's supply chain or 'life cycle' (Hart and Dowell 2011). Product stewardship allows collaboration within the supply chain to involve product design and the development process. The key resource of product stewardship is stakeholder integration. Greater stakeholder capabilities have been proven by the companies that have more proactive environmental strategies (Sharma and Vredenburg 1998; Ashby 2018). The higher order learning can be done through collaboration with external shareholders such as from institutions and government. A clean technology strategy suggests that firms build competencies in 'tomorrow' technology. Base of the pyramid (BoP) is based on the role of firms to 'meet the needs of the poor'. Firms can gain opportunities from the BoP (Hart and Dowell 2011).

Due to the lack of operationalization of this theory, McDougall et al. (2019) attempted to explain the NRBV in the study of the agri-food supply chain. Their findings suggest that pollution prevention is associated with pollution and waste from the internal operations. Through pollution prevention, firms receive a financial reward. Product stewardship corresponds to sustainable orientation in the supply chain. For instance, selecting suppliers based on the most sustainable ones that are available. Clean technology is related to renewable energy use in producing food, including the use of water technologies, and innovative farming processes. BoP is not featured in their research, instead they propose a new element in the NRBV: local philanthropy. Empirical research using the theoretical lens of NRBV is used to investigate causes of food loss and waste in the agri-food supply chain (Mena et al. 2014; Rodrigues et al. in press). We posit that NRBV shares common principles with CE. Departing from genuine concern for the sustainability of the firms which can be constrained by the firms' interaction with natural resources, NRBV argues that firms should have a proactive environmental strategy. Similarly, CE is concerned with the exploitation of natural resources within the current linear system. For instance, pollution prevention has consequences: waste prevention and preventing negative externalities, which are CE principles. In light of this background, this paper fills the gap in the literature by researching the adoption of CE in the upstream agri-food supply chain using NRBV theory, as research using this theory in CE is lacking (Mishra et al. 2019; Kusumowardani and Tjahjono 2020).

2.3 Transaction cost economics

Transaction cost economics (TCE) was made popular by Williamson (1979). Examples of transaction costs are contract cost, negotiation cost, monitoring cost, information cost. For supply chain management, the economic theory underlying TCE offers significant insights. Using the theoretical framework of TCE, a large number of testable theories concerning supply chain management can be formulated (Hobbs 1996). Due to the high abstraction of TCE, Hobbs (1996) identifies four key concepts of TCE. The first concept is bounded rationality, which indicates that while people may wish to make a rational choice, bounded rationality prevents them from making a rational decision due to physical limitations. Bounded rationality becomes an issue when there is uncertainty. The second concept is opportunism which has been defined by Williamson (1979) as 'self-interest seeking with guile'. The businesses and individuals will sometimes seek to exploit the situation due to their own interests. The third concept is asset specificity, i.e. when firms collaborate in investing assets in their exchange. The fourth concept is informational asymmetry. Firms recognize that many business exchanges are characterized by imperfect or asymmetrical information that arises from information being available only for selected parties. This suggests that all parties face the uncertainty that leads to behavior opportunism.

According to Liu et al. (2018), TCE potentially can be used to analyze relationships among actors in CE, for example in exchanging their waste into by-products. TCE can also be used to understand how businesses can close material loops effectively and establish close partnerships. These close partnerships enable businesses, along with partner businesses in the value chain, to deal with adaptation and pressures emerging from sustainability issues and increased environmental responsibilities. In these new economic conditions, the creation of contracts that are precise enough for the CE will decide how effective they will be in generating value (Lahti et al. 2018). Arguably, empirical work using TCE in the study of CE is limited. Figure 1 shows the framework used to investigate the implementation of CE using theories of NRBV and TCE.

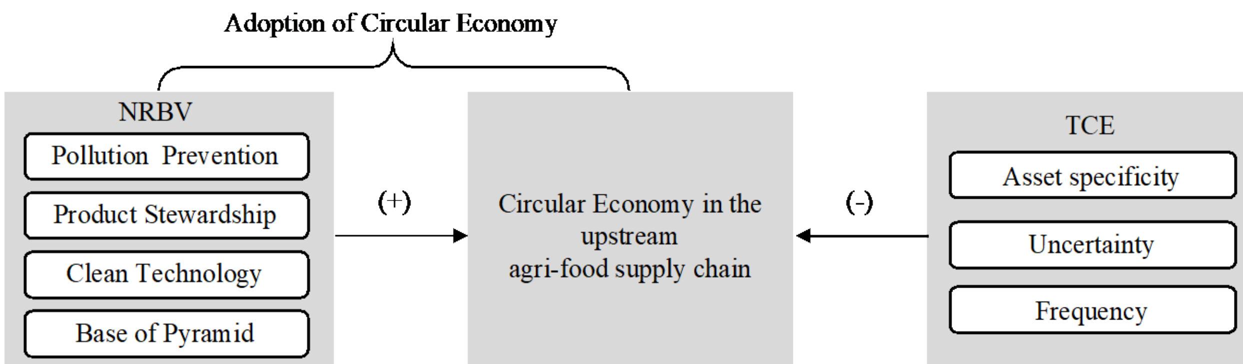

Figure 1. The framework of Circular Economy adoption

3. Methods

This research adopted a critical realism philosophical stance. Critical realism is the branch of philosophy which has relativism epistemology and stratified ontology (Bhaskar 1978). One of the characteristics of the critical realist is that they put reality as the most important philosophical consideration alongside a structural and layered ontology that is seen as crucial (Sayer 2000). Critical realism is based on the belief that there are only two ways to understand the world: 1) There are the sensations and events we experience; and 2) There is mental processing that goes on some time after the experience when we look back (Reed 2005). It is evident that operational research is growing in adopting critical realism which focuses on explanations of underlying mechanisms (Hanna and Jackson 2015).

The research design is a qualitative study using semi-structured interviews, which is appropriate to investigate the phenomenon in the early stages and to be effective in understanding the social phenomenon and expanding theory (Creswell and Poth 2016). Qualitative data in critical realism allows the researcher to obtain rich data and discover the underlying mechanism (Fletcher 2017). Multiple case studies (Yin 2018) are adopted to allow for comparison and to replicate multiple cases to achieve unique and consensus findings.

Data were collected from the case samples selection, using non-probability sampling, involving an upstream agri-food supply chain of ten growers in Java, Indonesia who grow horticultural products and supply to the modern retailers. We chose Java as it is the largest producer of horticulture in Indonesia (Wulandari et al. 2017). The horticulture products range includes banana, spinach, lettuce, zucchini, potato, cabbage and carrot. This research uses multiple data sources, both primary and secondary, and triangulation supports the robustness of the research. The primary data were collected from face to face interviews and visiting farm locations for observations, and the secondary data were taken from company websites. We interviewed ten growers as cases, represented by one informant from each case (A to J). We also interviewed one of the representative stakeholders in the Chamber of Commerce to ask for their views on CE, that we have coded as case K. In this research, there two types of growers: the first is growers who supply direct to modern retailers (represented by cases A, D, E, G, and J) and the other is using intermediaries (represented by cases B, C, F, H, I). The company's size range includes large, medium and small as variations in company size will provide validity and quality of data. Each interview lasted for 60-90 minutes.

Template analysis, a style of thematic analysis which has flexibility in building the coding structure (King 2012; Tranfield et al. 2003), was adopted in this research. The iterative process in developing the template, allowing deep engagement with data consistent with the philosophical stance of critical realism. The second researcher validated the codes. The template analysis was developed following the key construct of strategic capabilities in NRBV of pollution prevention, product stewardship, clean technology, and base of pyramid and TCE, which consists of four key concepts: bounded rationality, opportunism, asset specificity, and asymmetric information. We use qualitative data analysis NVivo in the coding process.

4. Results and Discussion

4.1 Pollution and waste elimination

Unlike the research on CE that considers using samples of large companies which are more established, we found some challenges to discovering CE in practice. This was due to the majority of growers not being familiar with the term. An example is explained by the following response from case H, when the researcher asked about the term CE, *"I am sorry, I do not think that I know that term, can you explain what it is?"* However, we noticed the emerging of CE in the growers by looking at the implementation of CE, such as how they use waste for composting. Case I explained that they did not understand the term CE, but they have done integrated farming, as the following excerpt shows: *"We implement an integrated farming system already, so actually, this is from the local genius of the founding fathers… if you want to be a grower you have to have animal husbandry, because there are vegetable leftovers from agriculture that will be used as feed for livestock and from them, we obtain manure which is useful as fertilizer"*.

In terms of pollution, all the cases of growers agree that pollution in the context of agriculture is associated with the use of pesticides that can contaminate crops, soil, wastewater and even the employees themselves. As stated by an informant in case H, *"In my opinion, pollution in agriculture is the use of pesticides"*. The conventional method of using soil as a medium for planting is a prevalent practice, therefore they cannot avoid the use of pesticides. However, food safety compliance has been understood by most growers, especially those growers who supply to the modern markets and have certification; they have received education from the government, their customers (modern retailers) and pesticide producers. The informants explained that even though they use these chemicals for growing plants, they do control the usage, so as not to exceed the maximum residue limit. They also admitted that they were introduced variations of pesticides but used them only when needed.

We also reveal that the understanding of waste is different among growers. Those growers who focus on the modern markets define waste as all the products that fall below specifications, but growers who supply other market segments have different views and associate the understanding of waste with other forms of waste. Case B responded that *"goods that cannot be used again are considered to be waste, like bottles and plastic"*. Cases B, C, D, E, F, and I argue that waste in relation to products is all the products that are unfit for human consumption. Case B is aware of the impact of the agricultural activities they do, first from the use of chemicals such as pesticides, then the use of plastic packaging and styrofoam. *"However, we have certification in Prima 3, in which it is prohibited for the land to have traces of or scattered plastic in the farm, but there is no pesticide in packaging, so it must be clean"*. A wide range of actions to eliminate waste start at the farms by using superior seeds, implementing best practice cultivation, and improving harvesting techniques and post-harvest management.

From the perspective of TCE, the influence of uncertainty contributes to creating waste for the growers. The growers do not have a guaranteed contract with their customers. There are a few cases between growers and their customers when the products are rejected because they are considered to be below specifications. High transaction cost occurs for those growers who supply direct to modern retailers. Case J explained, *"Sometimes retailers send the purchase order to us, then when we send products, but they are rejected with the reason given that they still have stock which then becomes waste"*.

4.2 Collaboration in the supply chain for Circular Economy

Stakeholders need to collaborate and support each other in the enactment of CE. The growers have realized the importance of collaborating with the stakeholders in the supply chain. The growers admitted there are complex challenges and some are posed by natural disasters. Therefore, they attempt to minimize risk by ensuring the important source of raw materials as being the key, which is seeds. The growers work together with seed producers to keep their harvest optimal. They also provide a small portion of land as a demo plot to test the performance of seed, as the informant in case J explained: *"The seed producer collaborates with us in testing the seed; we provide a demo plot before we plant on a large scale"*. In the TCE, the assets specificity concept appears in how growers collaborate with seed producers to protect the interests of growers in obtaining superior seeds. Collaboration also helps the growers to divert their crops to other channels. Market diversion is one of the efforts made in the ten cases who had experienced off-grade specifications. That is why the network is an important resource to have, as stated by an informant in case C. People who come to traditional markets are less demanding for perfect specifications; instead they are considered to be price sensitive, as suggested by informant case D. This suggests the importance of effective information flow in the supply chain when considering the perishable characteristics of products. However, for growers there is still a potential risk from opportunistic behaviors from the customers that arise from diverting products to other channels.

A higher-order learning process through collaboration with external stakeholders is also apparent in how growers acquire knowledge to improve their performance. This learning style, to a large extent, was akin to what was deliberated by Moreira and Tjahjono (2016), though the industry sector was slightly different. One company is working jointly with third parties who provide guidance in better practice cultivation, as case D alluded, *"We are also accompanied in doing cultivation and applying technology to agriculture, by NGOs from the Netherlands and Japan, so we receive a lot of transfer of knowledge from them"*. Support from the university was also perceived to be very beneficial for case I who had been provided with a gondola to carry harvest and materials from one site to another and had been helped to improve their knowledge.

We find one perspective from informants is regarding the need to collaborate with higher stakeholders in order for CE to be fully implemented. As such, stakeholders who are considered to be able to accelerate the implementation of CE are universities and government. Bounded rationality appears to be a barrier to the implementation of CE because of a lack of understanding about this system. Case I alluded that the implementation of CE needs stakeholder integration, *"We need knowledge on how to implement CE because we do not know how to do that; maybe we need support from the university, a person like you"*. Case H explained in detail, *"One of the big companies in Indonesia that was successful in implementing this [CE] was managed by an integrated system… but again it is hard to implement if we do not collaborate because we have different interests; however, if the management is under one roof it is easier to implement. Maybe we need a government who can actualize this system"*. A fundamental change is also required in order to adopt CE. One of the informants from the stakeholders, stated that CE is possible to be implemented in Indonesia; however, the future is in the hands of the younger generation of millennials who are willing to learn, are fast learners, and more knowledgeable in terms of technology. As the following excerpt indicates, *"We rely on the young, millennials, they are adaptive to technology, fast learners, they are really the agents of change. The older generation is not keen to adopt new knowledge"* (case K).

4.3. Technology adoption in supporting Circular Economy

In this study, discussing technology adoption is related to one of the NRBV strategies, that is clean technology; this includes the tools, machinery, cultivation system, and water management system. Most of the actors who use a conventional technique (on soil) rely on the basic tools, whilst growers who use greenhouses have adopted more advanced technology in their watering system using a nutrient film technique (NFT). Case A in the following excerpt states, *"Currently, we are using an NFT system but still have a conventional system using soil planting. In the future, we would like to use full NFT on our farm because it is easy to manage and faster in terms of the turnover"*. Another technology application is a water system using drip irrigation that was adopted due to the motives for conserving natural resources. In addition, it helps growers to manage their plants by applying centralized fertilizer in one place so that the application is in the same proportion for each plant.

Although technology has been extensively used in other contexts in order to have efficient operational routines that support CE, we identified that growers are not finding it easy to adopt technology – referring to the tools and machinery in the farms. This phenomenon was also revealed by Tjahjono (2009) who observed the adoption of (new) technologies in the shop floors posing various challenges to the workers, if the technologies do not fit the tasks (Greenough and

Tjahjono, 2007). Some trade-off of adopting technology has been acknowledged as in the example given by one informant: *"We are very keen to adopt technology to help us to be more efficient but technology is also still expensive; we have to be realistic, so yes, we still rely on being labor-intensive"*. We found that bounded rationality prevents growers from adopting technology that requires significant investment, although technology enables the process to be more efficient. Growers also experience a lack of capability in providing facilities to process waste to become nutrients. The investment has to be measured by the return on investment, and the growers have to be realistic regarding affordability. Besides the financial constraints, we found the practical challenges of finding suitable technology at the farm also prevented growers from adopting the technology. The representative of Case B commented, *"Actually, we can use a machine, but in considering its ability, because the terrain is a bit tilted, this area is small, so from an efficiency level it is better to use a machine"*.

Further discussion about technology revealed that all cases admitted that the adoption of digital technology has had a tremendous impact on them. They can exchange information and communicate using a smartphone, which helps their operational activities. Growers rely on information exchange to upgrade their knowledge about farming techniques which ultimately contributes to the best practice of the growers. Case G exemplified, *"I learn knowledge and trends from other growers, through social media; many people upload, and I can learn from them"*. The information is also important for price information to prevent opportunistic behavior from other actors. Sometimes the middleman still plays and tries to take advantage of the state of asymmetric information. If compared to the past, growers have suffered greatly from the price game played by intermediaries when they supply to the traditional markets, but now they admitted the price is more visible with the information sharing between growers. Information exchange is also important to help growers in making decisions regarding the diversion of any products that do not meet the specifications of modern retailers.

4.4 Social orientation towards Circular Economy

In line with NRBV which argues that firms have an important role in alleviating social ills, the social aspect is also important in CE. The original concept of BoP posits that the growth of firms can be achieved by creating a new segment for the low-end consumers. The background to this thinking is the firm's efforts to find opportunities by creating other markets that can bring revenue to the company because of the saturated market. Instead of creating a new segment bringing potential revenue, the selling price becomes lower. This is because most growers are focusing on fulfilling the main market segment, i.e. modern retailers that buy their commodities at a higher price than traditional markets. Most modern retailers have market segmentation from medium to high class, i.e. products that are required to have a perfect cosmetic appearance. The form of BoP that we found is by diverting fresh produce to secondary markets, such as to the foodservice industry and traditional markets who do not stress the importance of specifications. The following statement from case J supports this, *"We do not produce for the low segment market because it is not our main market, but if there are products that are below the specifications, we sell them to the secondary markets"*.

We identify the negotiation price arises when the growers divert to other channels, especially if the growers do not have routine and regular transactions with the alternative channels. The characteristics of perishable products also mean that growers have no option but to save products from being wasted. Case A illustrates this: *"We have a special task force for fast selling, we call everyone to push selling out, rather than the products becoming waste"*. This corresponds to the study of Kistruck et al. (2013) who illustrates how BoP is constrained by the presence of the middleman who is trying to make a profit. Therefore, firms need to have good negotiation capabilities. This suggests the role of information flow becomes very important to avoid high transaction costs.

We also found BoP in the form of food donations, i.e. to give food that is suitable for human consumption to the employees; in fact, they are not integrated into the company's strategy or given their serious attention. Cases A and J explained that they give the products that are still edible to their employees, and they do that when there is surplus production. *"Yes, when the demand for vegetables decreased but the product has been overproduced"* (Case A). Another comment from case B about BoP was that *"We have a community of growers here, joined in one group and what we do must consider their welfare."* Similarly, case C involved the local community as part of their employees. Informant case C commented that by empowering and involving the people nearby that farming is supporting the economics of local people. One interesting finding is that there is a cultural barrier in donating to the community, as the informant from case E stated, *"If you want to donate products to the community, you should give the good ones not imperfect products"*.

In Figure 2, we summarize the adoption of CE in the upstream agri-food supply chain based on the theoretical lenses of NRBV and TCE.

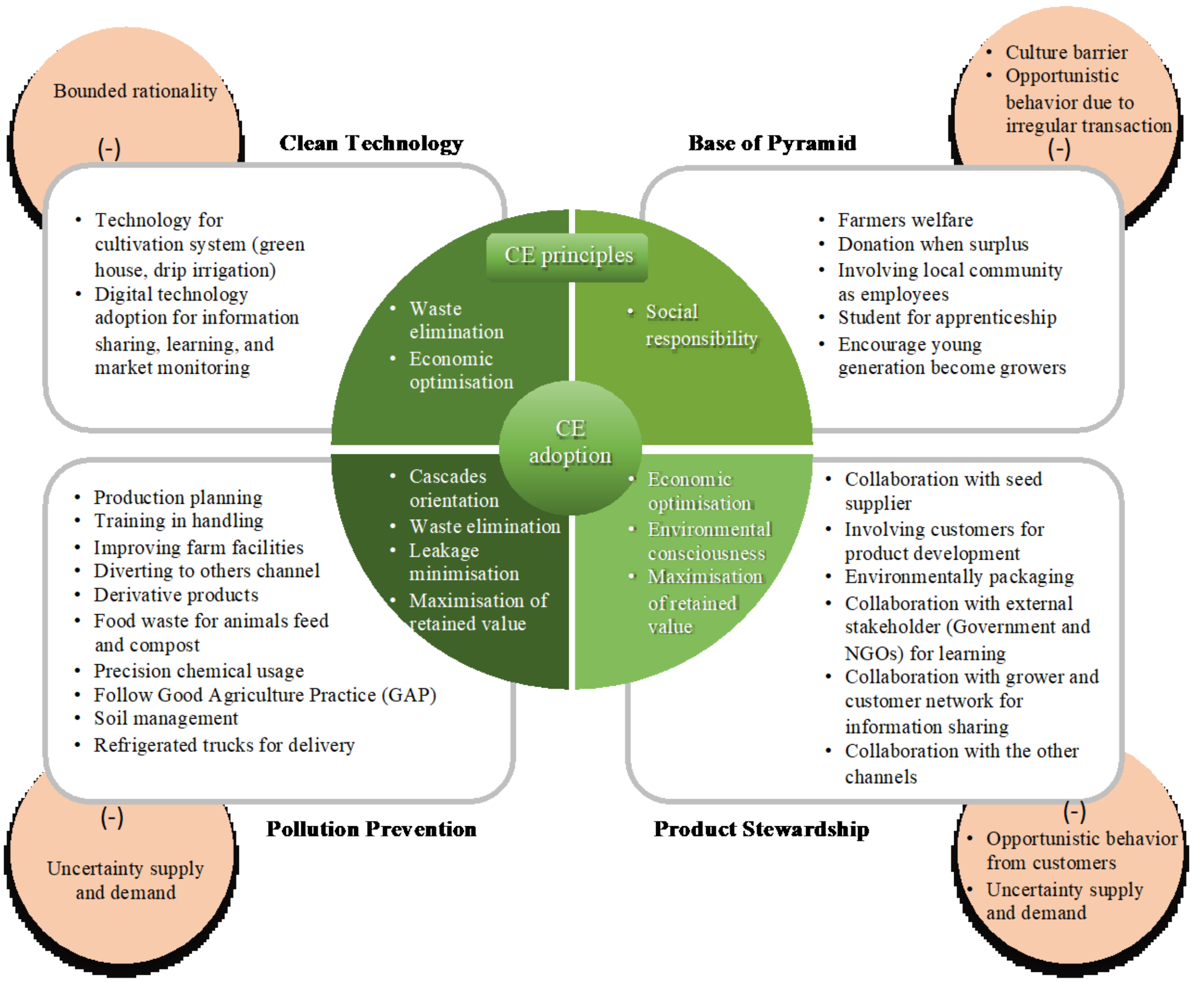

Figure 2. Operational level of Circular Economy adoption in the upstream agri-food supply chain

5. Conclusion

This research has answered the research question on the implementation of CE in the agri-food supply chain. The application of CE in Indonesia in the upstream agri-food supply chain is still in the early stages of development. Our investigation of pollution and waste elimination is realized because of growers' awareness of wasted resources and cost reduction. Collaboration becomes an enabler for the growers to secure raw materials and acquire knowledge. The adoption of technology is diverse amongst growers considering the heterogeneous resources and capabilities of growers. Social orientation has appeared by diversion to other channels, donation to employees, and local community involvement. The research contributes to the broader literature on CE in the upstream agri-food supply chain and extends the theories of NRBV and TCE in the upstream supply chain. The implications for future research include the need to investigate the capability required to fully implement CE using larger samples. Although this research was conducted in the upstream supply chain, it is possible to replicate the methods and same queries to the downstream agri-food supply chain. The practical implications of this research are better management of natural resources and references for implementing CE.

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Acknowledgements

The study described in this paper was part of the Circular Economy Research and Development Network for the Sustainable Food Supply Chain project. The authors appreciate the funding support from the Academy of Medical Sciences, grant number GCRFNGR3\1211, and the research collaboration between Coventry University and Universitas Indonesia.

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