Advancing bioplastic packaging products through co-innovation: a conceptual framework for supplier-customer collaboration

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ADVANCING BIOPLASTIC PACKAGING PRODUCTS THROUGH CO-INNOVATION:

A Conceptual Framework for Supplier-Customer Collaboration

ABSTRACT

Bioplastics are considered to be an ideal replacement for conventional plastic packaging, but there seem to be considerable barriers to further development of the industry due the mismatch between the characteristics of bioplastics packaging and the products they are intended for. The collaboration between the bioplastic packaging producers and the product manufacturers should, therefore, result in the improvement of product functionality and innovation in packaging technologies. This paper explores the extent to which co-innovation has been adopted in the development of bioplastic packaging products within the context of supplier-customer collaboration. The paper reveals the key research gaps in co-innovation for bioplastic packaging, which also lead to the development of comprehensive indicators of bioplastic packaging product innovation and a conceptual framework that elaborates the co-innovation mechanism. The framework extends the existing concepts of co-innovation by adding several key mechanisms of joint activities, joint resources and relationship management, that ultimately act as the critical success factors of the co-innovation process in bioplastic packaging.

Keywords: Bioplastics, bioplastic packaging, product innovation, sustainable product development, supplier-customer collaboration.

1. Introduction

Plastic packaging is widely used in daily life, industries and other sectors in the economy and because of its high performing features and low cost of production (Dobrucka, 2019; Khan et al. 2016; Razza et al., 2015); however, plastics leave solid waste material, creating other serious environmental problems (EMF, 2017; Lewis et al., 2017; Soylu & Dumville, 2011).

A proposed solution to minimise the negative impact of plastic packaging is by substituting the source from fossil-based to biodegradable materials (Chadha, 2011; de Vargas Mores et al., 2018). Biodegradable plastics (referred to as bioplastics hereafter) are considered to be an ideal replacement for conventional plastic packaging because of their biodegradable characteristic, i.e. the ability to break down into natural elements with the help of microorganisms or specific processes (Verghese, Lewis & Fitzpatrick, 2012), thus, becoming a promising way to solve the solid waste problem in the environment (Ahmed et al., 2018). In addition, bioplastics are less dependent on fossil-based resources because they can be produced from renewable resources such as plant starch or derived from bacterial fermentation of plant material (Ahmed et al., 2018; Khan et al., 2016), and therefore, bioplastics are considered to be a radical eco-innovation (Chadha, 2011; Lin & Wu, 2014)

Even though the bioplastic packaging industry is developing due to the increased awareness of sustainability, market demand and regulations, there are barriers to the further development of the industry. Currently, the turnover of bioplastics is limited to only around 1% of the global plastic circulation (European Bioplastics, 2018) and problems in the application often exist between the packaging manufacturer and the product manufacturer. The packaging manufacturer processes the bioplastics raw material into packaging (Benetto et al., 2015; Sossa et al., 2015), but particular desired functions or performance is lacking, and its quality is lower compared to the conventional fossil-based packaging (Khan et al., 2016; Theinsathid, Chandrachai, & Keeratipibul, 2009); thus it is not fit for use for the product manufacturer’s products. For example, certain bioplastic packaging has a low barrier to air or water vapour (Benetto et al., 2015), so when used for food and fresh produce, the contents easily lose moisture from evaporation, becoming dry and causing a shorter product shelf life (Khan et al., 2016).

Successful product development is not only about implementing new technologies, but also ensuring that it is fit for customers' needs and becomes a solution for customers' problems. Understanding users' needs and providing solutions will promote market acceptance of the new invention (Lacoste, 2016; Theinsathid et al., 2009), reduce the risk of market uncertainty and overcome technical barriers (Chadha, 2011; Melander, 2017). De Propris (2002) suggests that companies achieve higher innovation performance, indicated by the creation of a new or improved product or process, if they cooperate with other companies instead of working in isolation (de Propris, 2002). Therefore, supplier-customer collaboration is believed to be the key to this success.

The importance of supplier-customer collaboration in the packaging industry, bioplastics and sustainable product development, has been highlighted by several studies (Arnold, 2017; Chadha, 2011; Jeong & Ko, 2016; Kishna et al., 2017; Morgado, 2008; Theinsathid et al., 2009). Through a case study, Morgado (2008) and Slater (2010) show that supplier-customer collaboration in packaging product development results in the improvement of product functionality and creates innovative packaging. Collaboration in sustainable product development adds value to the final product by being recognised as eco-friendly and reducing the cost of production from the supply chain integration (de Vargas Mores et al., 2018). Collaboration for product innovation becomes more necessary as more regulation and incentives are applied to environmentally friendly products, including bioplastic packaging (Abdullah et al., 2016; Lee & Kim, 2011; Melander, 2017). In the future, more demand for bioplastic packaging is predicted (European Bioplastics, 2018) and companies can create competitive advantage by being first movers or leaders in this green technology (Kishna et al., 2017; Melander, 2017) through supplier-customer collaboration.

In this study, the supplier-customer collaboration in bioplastic packaging product development refers to the concept of *co-innovation*, as new ideas or approaches from various internal and external sources are synergised to create new value for customers or other stakeholders

(Baldwin & von Hippel, 2011). The core of co-innovation includes convergence, a collaboration of ideas, actions and resources to create value that is difficult to imitate by competitors (Bitzer & Bijman, 2015; Lee, Olson, & Trimi, 2012). In this study, the 'supplier' refers to the packaging manufacturer, and 'customer' refers to the product manufacturer, following the packaging supply chain (Verghese & Lewis, 2007), see Figure 1.

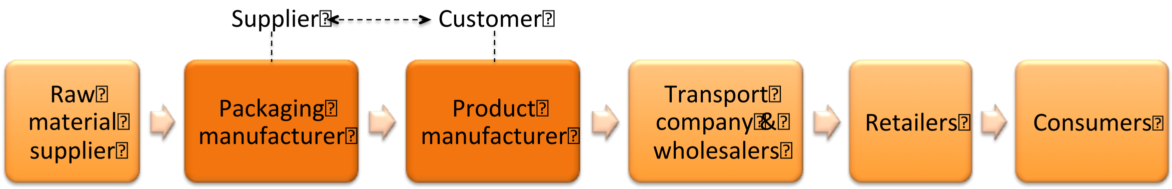

Figure 1 - The packaging supply chain (Adapted from Verghese & Lewis (2007)

Supplier-customer co-innovation in bioplastic packaging product development is essential and needs to be studied to address problems regarding the limited application of bioplastic packaging due to product fit for use issues. A literature review is employed to find out the extent to which co-innovation is implemented in the context of bioplastic packaging. Further detailed questions need to be answered to achieve the aim of this literature review:

RQ1: What is the recent development of bioplastic packaging, including, product attributes and performance, and development methods?

RQ2: To what extent has co-innovation been studied in the context of bioplastic packaging product innovation?

RQ3: How co-innovation is conducted between organisations and processed from the development towards the final product?

RQ4: What indicates the advance bioplastic packaging as the outcome of co-innovation?

This paper is structured in sections, as the following: Section 2 explains the definition of co-innovation, theoretical lenses used to understand the process and mechanism of co-innovation that also underlying the synthesis. Section 3 presents methodology chosen to conduct the literature review comprising the mechanism of data generation from databases, the selection process and data analysis. Next, section 4 shows the descriptive section 5 broadly explains the thematic analysis elucidating the patterns and findings that answer the research questions. The discussion in section 6 identifies research gaps, and elaborates the findings to develop a conceptual framework that will guide further research. Finally, a brief summary of the findings, implications for managerial practices, limitation and opportunities for future research are presented in the conclusions.

2. Theoretical perspective

2.1. Definition of co-innovation

The supplier-customer collaboration in bioplastic packaging product development refers to the concept of *co-innovation* – firm activities that involve the collaboration of business partners in a process and mechanism to create value (Bitzer & Bijman, 2015; Tsou, Cheng, & Hsu, 2015). Maniak and Midler (2008) used the automotive manufacturing new product development context to define co-innovation as the cooperation with the supplier with aim of developing innovative features. Similarly, inter-firm cooperation over innovation is termed joint innovation, and mostly occurs between buyer and supplier; it involves joint activities and joint commitment on resources such as R&D, technology development, new products and processes development, training, financing and marketing (de Propris, 2002).

Essentially, co-innovation is considered as a way to synergise efforts and investments from internal and external contributors to create valuable new products, processes or services (Baldwin & von Hippel, 2011). Tsou et al. (2015) consider co-innovation to be a mechanism of producing or improving products or service for the customer; and from the service delivery perspective, value for the customers can be created through the integration of products with service. Furthermore, co-innovation is also seen as a three-dimensional process: the collaboration of actors; complementary integration of technology, organisations and institutions; and coordination among levels in the value chain (Bitzer & Bijman, 2015). Similarly, Yeniyurt, Henke and Yalcinkaya (2014) used co-innovation terminology to address the longitudinal process of collaboration involving suppliers for new product development; and demonstrated that co-innovation positively influences performance measured by new product launches and sales (Yeniyurt et al., 2014).

This study adopts the underlying principle of co-innovation as a mechanism (Baldwin & von Hippel, 2011; Maniak & Midler, 2008; Tsou et al., 2015) and process (Bitzer & Bijman, 2015; Yeniyurt et al., 2014), involving inter-organisational collaboration, complementary convergence or integration of multidimensional resources (Bitzer & Bijman, 2015; Lee et al., 2012), joint activities (de Propris, 2002), knowledge absorption (Maniak & Midler, 2008) and value creation for customers that are difficult to imitate by competitors (Lee et al., 2012).

2.2. Relational view

The collaboration between customer and supplier enables the integration of resources or capabilities owned by each partner, and it is essential to facilitate both supplier and customer to co-develop a breakthrough innovation (Perez, Whitelock and Florin, 2013). For example, in the context of this study, the packaging manufacturer, while having valuable expertise in bioplastics but lacking an understanding of its application to the product, cannot market the packaging. On the other hand, product manufacturers will find it less feasible to build a bioplastic packaging production unit due to lacking capabilities in bioplastics (Lee & Kim, 2011). Supplier-customer collaboration may, therefore, resolve the problem in the applications of bioplastic packaging that many of their competitors cannot. Accordingly, unique resources that can be built at the supplier-customer supply chain level will become an inimitable weapon (Ketchen & Hult, 2007); therefore relational view (Dyer & Singh, 1998) is used as the theoretical lens.

The relational view theory is developed from the resource-based theory and explains that resources can be combined, i.e. from the external organisation, to achieve competitive advantage (Dyer & Singh, 1998). Moreover, four sources: relation-specific assets, knowledge-sharing routines, complementary resources/capabilities, and effective governance, should be developed with the supplier, customer, government and other external entities to achieve relational rent (Dyer and Singh, 1998, p. 662), i.e. "*a supernormal profit jointly generated in an exchange relationship that* *cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners*". The relational view, in line with other theory such as transaction cost economy and organizational design theory, implies that successful supplier-customer collaboration requires a mechanism (Petersen, Handfield, & Ragatz, 2005). The mechanism to attain performance and resource uniqueness incorporates the inter-organisational asset interconnectedness, partner scarcity and resource indivisibility (Dyer & Singh, 1998).

By drawing upon the concept of relational view, several studies supported the importance of learning from collaborating partner to successfully create value. In particular, learning and exchanging product-related knowledge should be routinised in every stage of product development (Huber, Nohammer, & Stummer, 2011). Additionally, Perez, Whitelock and Florin (2013) demonstrated that a learning mechanism evolves from exchanging existing knowledge to co-developing new knowledge and innovation and stressed the role of absorptive capacity.

2.3. Absorptive capacity theory

In order to gain more understanding of the inter-organisational learning mechanism, such as learning in technical areas (Chadha, 2011), and sharing information for developing sustainable product (Lacoste, 2016), the absorptive capacity theory (Zahra & George, 2002) is used to complement the understanding of knowledge-sharing routines (Dyer & Singh, 1998)

The absorptive capacity theory seeks the extent to which an organisation can recognise external new knowledge, and acquire and implement it to achieve innovation (Cohen & Levinthal, 1990). The mechanism to exploit external knowledge depends on four capabilities: acquisition, assimilation, transformation and exploitation (Zahra & George, 2002), and is also determined by demand-pull and science-push to achieve innovation (Murovec & Prodan, 2009). To further investigate the role of absorptive capacity, Aboelmaged & Hashem, (2019) used the green, small and medium-sized enterprises (SMEs) context and revealed the absorptive capacity to be a strong predictor in green innovation adoption. However, Tavani, Sharifi, & Ismail, (2014) showed that a certain level of absorptive capacity is required in order to achieve successful co-innovation.

3. Methodology

This study employs a systematic literature review (SLR) as it provides a clear mechanism and a stringent review protocol performed to minimise researchers' bias and maintain the independence of the research process, yet allowing exploration and discovery that contributes to developing an understanding (Tranfield, Denyer, & Smart, 2003) about the process of co-innovation in the bioplastic packaging context. The SLR method in this study is adapted from Tranfield et al. (2003), consisting of data collection, data analysis and synthesis phases.

3.1. Data collection

Data collection was carried out following the protocol, in the form of a step guide to maintain the focus of research on problems that need to be answered while maintaining the objectivity of the SLR (Tranfield et al., 2003). The protocol used in this SLR included a search strategy and criteria for inclusion directed to answering the literature review questions.

The search strategy included the identification of and decision for using the relevant keywords and search terms, database selection, followed by the trial and modification of keywords and search terms, and implementation of the search strategy. This SLR used five databases considering the context in the areas of business management, strategy and sustainability, and the availability of full-text peer-reviewed scientific literature: Business Source Complete (EBSCO), ABI/INFORM (ProQuest), Scopus, ScienceDirect, and Emerald. The search used Boolean operators such as AND, OR, and NOT to narrow or expand the search using combinations of keywords (Galvan & Galvan, 2017). Additional criteria were applied to limit the results to peer-reviewed academic journal articles written in English, within 20 years period, from 2000 to 2019. The consideration to include 20 years is due to the limitation of literature in ten years that only one article was found (Theinsathid et al., 2009) quite relevant. Therefore, the period is extended to year 2000 to facilitate further exploration on bioplastic packaging studies, ideas and concept of co-innovation in the earlier period. The search from the five databases retrieved 1,440 articles. Figure 2 shows the search strings and filtering criteria used in the Scopus database.

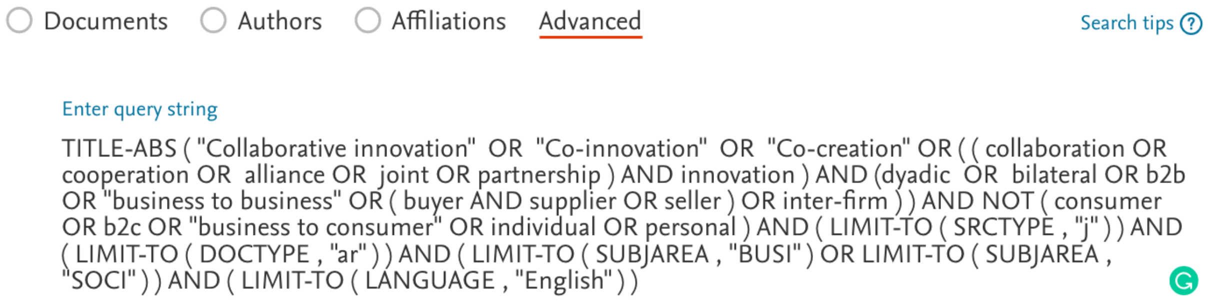

Figure 2 - An example of the search strings and filtering criteria

The selection of articles in this SLR followed a systematic protocol that included determining the selection criteria and documentation, filtering article duplication among the databases, and selection based on the title, abstract and full-text (Tranfield et al., 2003). The criteria for inclusion of the articles were predetermined to ensure the selection process was consistent for all articles, and minimised human error and bias (Tranfield et al., 2003) by using an assessment checklist that prioritised the purpose, findings and implications related to research questions or topic of the research, and also the relevant context of the study (Lusiantoro et al., 2018). These criteria enabled an extensive exploration of existing and emerging ideas, and concepts relevant to co-innovation in bioplastic packaging.

The title selection was made by first including only peer-reviewed articles from an academic journal, followed by evaluating the relevance of the title to the context of co-innovation, co-creation, co-development or co-production in B2B supplier-customer relationships. Next, the selection of articles based on the abstracts followed the assessment criteria, then the decision to include an article was based on being relevant to the context and where the contributions to the literature review questions were significant. In the full-text selection, all articles were carefully read; each was then evaluated based on three categories: contribution, theory and methodology, then given a score from 0 (absence), 1 (low), 2 (medium) to 3 (high) for each category following predetermined assessment criteria. Articles were selected if they scored at least 2 (medium) for each element of consideration. Two reviewers were involved in the assessment process, and the third reviewer was involved in deciding when the two reviewers gave a different decision on the inclusion of an article. The implementation of the data collection protocol, selection procedures, and the search results are summarised in Figure 3.

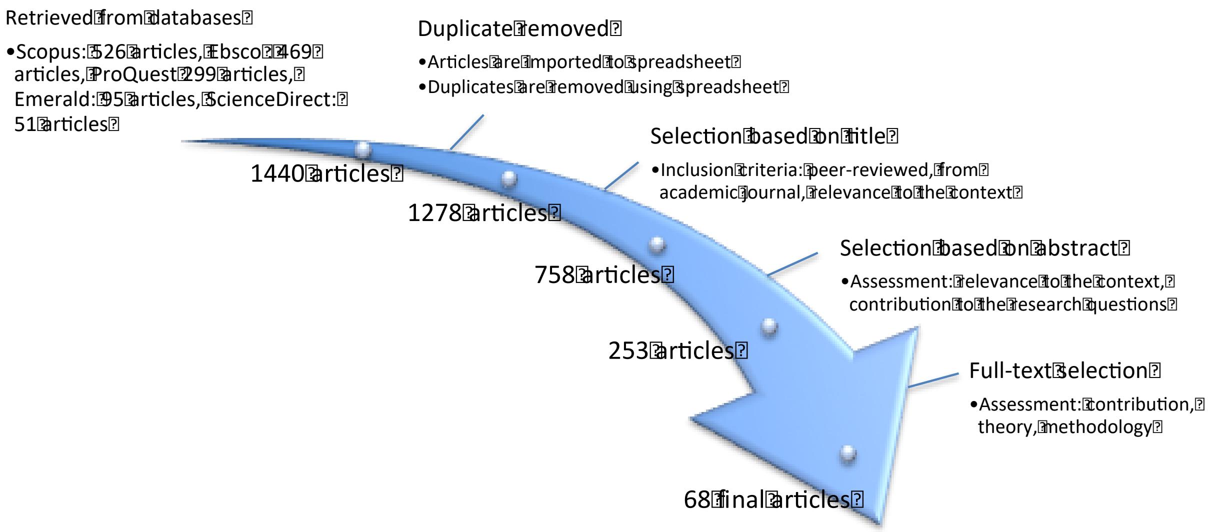

Figure 3 - The implementation of data collection protocol

<u>3.2. Data analysis</u>

After retrieving the final set of articles from the multiple appraisal processes, the next process was to analyse the data using both descriptive and thematic analyses. Descriptive analysis was used to depict the profile of the articles using simple categories (Tranfield et al., 2003) to facilitate the recognition of pattern and trend among categories in order to support interpretation and understanding of a phenomenon. Thematic analysis was adopted to identify, analyse and report patterns (themes) within data as well as organise and describe data set in rich detail (Braun & Clarke, 2006). In the thematic analysis, the interpretative approach was used to extract data from the collection and identify consensus or emerging themes (Tranfield et al., 2003).

Template analysis was adopted as the data extraction technique due to its advantages in accommodating a balance between structure and flexibility by using a coding template to correspond to the researcher's need during the analysis with less time-consuming and complicated procedures (King, 2012). Therefore, the template analysis can manage large data more efficiently, as with the number of articles to be analysed in this SLR. *A priori* codes were developed based on the research questions, which included ‘bioplastics materials for packaging’, ‘bioplastic packaging product characteristics’, ‘challenges in the bioplastic packaging industry’, ‘co-innovation in bioplastic packaging’, ‘mechanism of co-innovation’, ‘the existing framework of co-innovation’, and ‘the outcomes and impacts of co-innovation’. The *a priori* codes also included ‘research design’, ‘unit of analysis’ and ‘definitions’ of important terms related to co-innovation.

The coding process was carried out by two researchers who independently extracted relevant data addressing the research questions. The articles were carefully read, then relevant text, significant information and recurring topics were each given a code using a word or short phrase representing the essence (Braun & Clarke, 2006; Saldana., 2013; Tranfield et al., 2003). The coding process was managed using NVivo, a qualitative data analysis software tool. The following are some examples of codes emerging from the coding process, which are related to the implementation of supplier-customer co-innovation: *co-location to customer's plant, environmental knowledge, joint investment, allocation of idiosyncratic investment, joint team, work as a team with client's staff, specialised production units and technology integration*. All of these codes were grouped under the ‘mechanism of co-innovation’ code.

Having examined the entire articles, the next process was to collate the themes that emerged from the coding process. This was done by the two researchers who coded the data, and an additional researcher who provided a neutral perspective, especially if there was a difference in opinion in assessing the relevant patterns to become themes. During the review process, codes were updated, added, combined or deleted if necessary. For example, the ‘allocating idiosyncratic investment’ code was merged with the ‘joint investment’ code, which represents the tangible or intangible investments dedicated by both supplier and customer involved in the collaboration. Subsequently, the emerging patterns were discussed and themes were created, given names based on the essence of a particular pattern, then the relevant codes were re-arranged under a specific theme. For example, the theme of ‘joint resources’ was created to represent the resources allocated by customers in joint product development; this theme comprised the codes of ‘co-location to buyer's plant', 'environmental knowledge', 'joint investment', 'joint team', 'specialised production units' and 'technology integration'. The final themes were organised in a list (see Figure 4), and will be presented in the thematic analysis section.

1. The current situation regarding bioplastics packaging
   1.1. The characteristics of bioplastics packaging
   1.2. Problems in the application as packaging
2. Existing studies on co-innovation in bioplastics packaging development
3. The process and mechanism of co-innovation refer to general packaging and sustainable product development co-innovation
   3.1. Co-innovation in the general packaging
   3.2. Co-innovation in sustainable product innovation
      3.2.1. Phases of collaborative product development
      3.2.2. Mechanism of co-innovation in sustainable product innovation
         3.2.2.1. Sustainable oriented relationship management
         3.2.2.2. Joint activities through co-creation, co-development and transfer knowledge
         3.2.2.3. Joint resources in product development
4. Outcome of co-innovation

Figure 4 - The final themes in the thematic analysis

3.3. Synthesis

Data synthesis presents the known and unknown facts, the extent of which consensus exists across themes based on the descriptive and thematic analysis that contribute to answering the literature review questions (Tranfield et al., 2003). The interpretation and arguments are more than just showing the meaning of the data; they also reveal the assumptions, implications, conditions, and reasons to present robust logical analysis (Braun & Clarke, 2006). In addition, template analysis accommodates discussion of the differences and consistencies between case studies to present the participants' perspectives (King, 2012). This is adopted in the synthesis by presenting consistencies and specificity based on industry sectors, general packaging and sustainable product. Furthermore, the synthesis in this study presents the phenomena of the application of bioplastic packaging that reinforce the need for co-innovation, comprehensive indicators for bioplastic packaging product innovation and a conceptual framework for the mechanism of supplier-customer co-innovation.

4. Descriptive Analysis

The final 68 articles covered various disciplines, such as strategic management, operations management and supply chain management. Out of these 68 articles, 11 were retrieved from the Journal of Cleaner Production and five were from the Business Strategy and the Environment journal; all of which were closely pertinent to bioplastics, packaging and sustainable products; and were relevant to the scope of the journals in interdisciplinary research contributing to the understanding of business views and strategies regarding environmental management practice and regulation. Three articles were retrieved from Management Decision journal, which covers studies in operations management, problem-solving and strategy, all of which were in-depth studies in co-innovation. Other articles from various journals, such as International Journal of Production Economics, International Journal of Operations & Production Management and Journal of Product Innovation Management, were also captured using the data collection protocol, supporting the contributions to the research aim and objectives. The full list of journal sources selected for the analysis is provided in a spreadsheet, see supplementary data: sheet "2_Num_Articles_per_Journal"

Figure 5 shows the number of articles is very limited before 2010; the articles related to co-innovation (Bossink, 2002) and supplier-customer collaboration in product development (Croom, 2001; Farrow, Johnson & Larson, 2000, Morgado, 2008) are quite limited and not yet studied bioplastic packaging; nonetheless, there was a review on the emerging start-ups in bioplastic industry (Theinsathid et al., 2009). From 2010 to 2014, there are 20 articles, which most of them explored the inter-firm collaboration and co-creation in manufacturing industries including the plastic and packaging sectors (Lee and Kim, 2011; Hofmann et al., 2012; Perez et al., 2013; Baraldi et al., 2014); albeit only two articles studied bioplastics (Chadha, 2011; Sarobol et al., 2013). Then, up to 2015, the topics of bioplastics and sustainable products are then emerging, covering product development and the environmental impact evaluation assessment (Benetto et al., 2015; Razza et al., 2015; Kuzincow and Ganczewski, 2015) and supplier-customer collaboration (Chen et al., 2015; Fang et al., 2015). This phenomenon is likely due to the establishment of the Sustainable

Development Goals in 2015, and the increasing global attention to sustainability. These topics continue to be interests of study until today, covering more diverse views from business strategy (Jeong & Ko, 2016), co-innovation (Arnold, 2017; Melander, 2018), supply chain management (de Vargas Mores et al., 2018), customers' perspectives (Boesen, Bey, & Niero, 2019), circular economy (Gong et al., 2019), application of bioplastic packaging for industries (Salwa et al., 2019) and co-innovation in bioplastic packaging industry (Junior et al., 2019). Detailed publication per year can be seen in Supplementary Data: Sheet "3_Publication_per_Year".

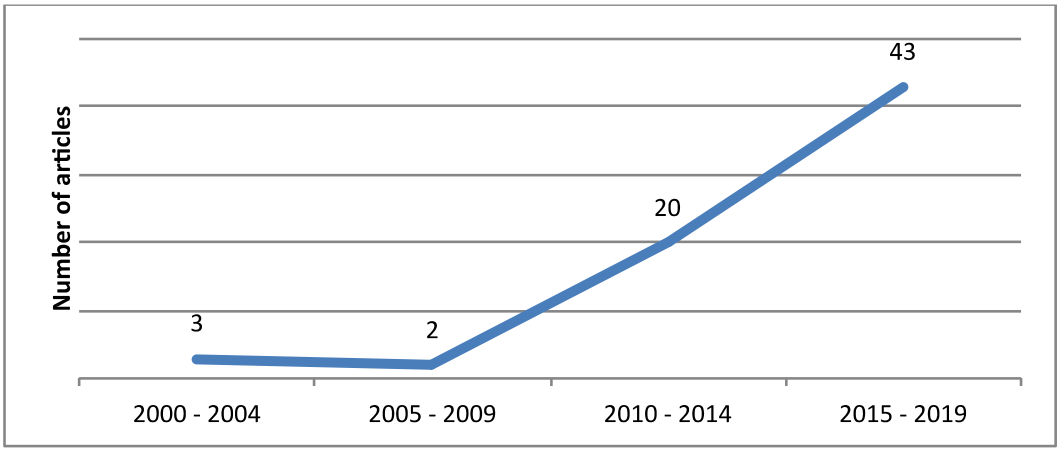

Figure 5 - Distribution of articles over latest 20 years

The articles included in the analysis are mostly specific to manufacturing industry (60%) comprising diverse sectors, such as bioplastics or plastics in primary form, packaging, electronic component, automotive, machinery and equipment, chemical, food and beverage; information and communication industry (4%), followed by construction; mining and quarrying industry. There are 24% of the articles focusing not only in one industry but incorporate multiple industries, which includes professional, scientific and technical activities; wholesale and retail trade and also manufacturing, information and communication industry. Figure 6 shows the percentages of articles based on the industry, which refer to the International Standard Industrial Classification (ISIC), see further detail in Supplementary Data: sheet "4_Num_Articles_per_Industry". This distribution indicates the prevalence of the inter-firm co-innovation for product development to the manufacturing industry. Additionally, concept and best practices from other industries, which were relevant to the purpose of this study were included in order to build a comprehensive understanding of the concept of co-innovation and its implementation.

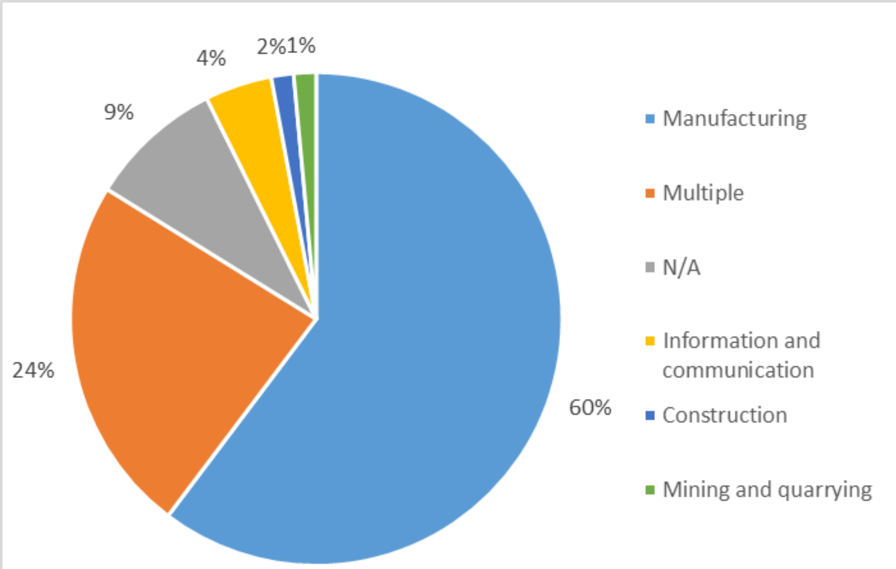

Figure 6 - Distribution of articles based on the industry

Keywords indicate important terms that describe a particular study. Figure 7 presents several keywords that frequently appeared in the literature, which also shows the general view of the research topics in the selected literature. The most widely used keyword was "innovation", which continued used over 12% of all keywords, and was found in various combinations such as "green/environmental/sustainable innovation", "collaborative innovation", "open innovation" and "co-innovation". Besides, the keywords "green", "sustainable" and "environment" are each used around 6%, where examples of usage are "green products", "green new product growth", "sustainable development", and "environmental collaboration". Meanwhile, the keywords "bioplastics" and "biopolymers" are used in a number of combinations such as "bio-based plastic", "biopolymer technology", of which the frequency is less than 3%. And after further exploration, the equivalent terms for "bioplastic" were found, such as "green plastic", "biodegradable packaging", "bio-based packaging", "sustainable packaging", "green polyethylene", "polyethylene terephthalate (PET)", "polylactic acid (PLA)", "biodegradable packaging" and "bio-based packaging", all of which comprising 4% of all keywords. Overall, the keyword frequency described a large part of the selected literature studied innovation, and some were specific to co-innovation; thus are in accordance with the objective of this study. However, specific studies on bioplastic packaging were still limited, and therefore the references in the relevant broader scope were also included for the analysis, such as green innovation, sustainable product development in manufacturing industries. Please see Supplementary Data: sheet "5_Keyword_Frequency" for detailed information on the keywords analysis, the percentage of most used keywords and the keywords combinations.

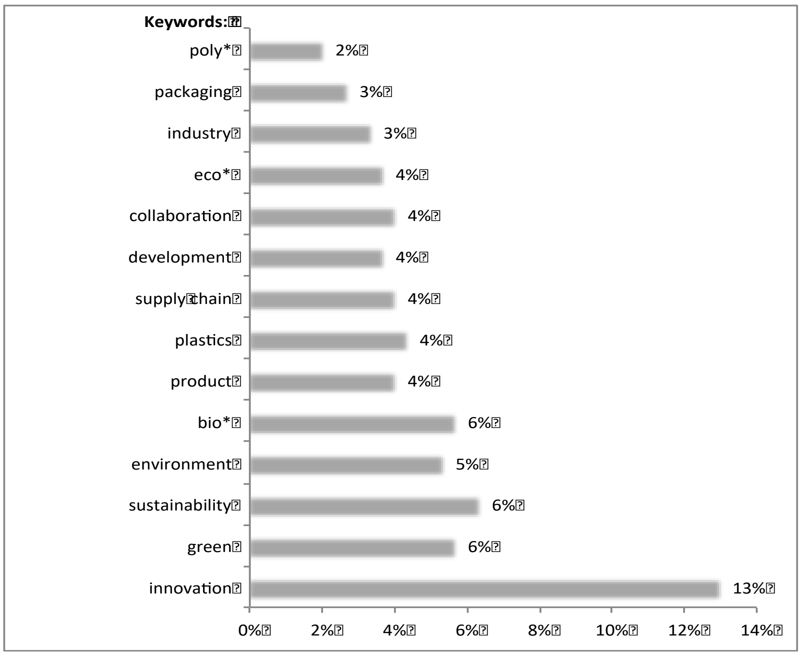

Figure 7 - Distribution of most used keywords in the literature

Moreover, there were some references, which were widely cited and can be said to be important as references for other studies, including this study. Based on citation in the Google Scholar until December 2019, the most cited reference with 651 citations, Lee et al. (2012), described the evolution of innovation from closed innovation, open innovation to co-innovation. The significance of this study is the development of concepts and scope of co-innovation that integrates ideas from internal and external organizations to produce shared values through a platform aimed for convergence of expertise and ideas, collaboration and value co-creation (Lee et al., 2012). The second most cited (592 citations) paper was a case study about the adoption of sustainability and innovation practice by SMEs in rubber and plastic manufacturing industry (Bos-Brouwers, 2010). This study pointed out that sustainable innovation is not easily attainable in SMEs, and the practice of incremental innovation is more apparent than radical innovation (Bos-

Brouwers, 2010). Another critical study was from Saarijarvi et al. (2013), cited by 323, which explained the mechanism of value co-creation, the types of values that can be created and the assessment of opportunities before implementing value co-creation. Lesson learned from these studies were the importance of resources dedicated into the co-innovation, such as joint product/service development and production, by the collaborating partners (Bos-Brouwers, 2010; Saarijarvi et al., 2013). Finally, future research on the mechanism of sustainable innovation was highlighted due to the infancy of studies in this field (Bos-Brouwers, 2010).

Descriptive analysis has provided the profile of the papers based on the journal, year of publication, industry and keywords. This simple grouping facilitates discovery to the emergence of trends, specific themes or differences between groups that are useful for thematic analysis in the next section.

5. Thematic Analysis

5.1. Development of bioplastic packaging: product characteristics and their implications

This section corresponds to the first research question, elucidates the recent development of bioplastic packaging, focusing on the product characteristics that have been developed and their implication to the adoption of bioplastic packaging. First, the evolution of bioplastic packaging is briefly illustrated, followed by the analysis of the bioplastic packaging product characteristic based on the themes that were found during the data extraction process.

Until today, bioplastic packaging has evolved and gained more significance. However, before 2010, the bioplastic industry was far behind commercialisation (Theinsathid, 2009). Although bioplastic packaging offered advantages to the environment, and its demand was increasing, the mechanical properties of the bioplastics made from starch-based, polylactic-acid (PLA) and Polyhydroxyalkanoate (PHA), had not well developed, and the cost of production was less feasible for commercial application (Theinsathid, 2009). Then, from 2010 to 2015, there seem to be significant efforts from the plastic industry to expand to bioplastics (Chadha 2011). In line with that, more studies were found focusing on the product development, which was mostly evaluated on the environmental aspects using Life-Cycle Assessment and on the performance aspect using comparison to the conventional plastics (Sarobol et al., 2013; Kuzincow and Ganczewski, 2015; Sossa et al., 2015; Benetto et al., 2015; Razza et al., 2015). Since 2016, there were more adoptions of bioplastic packaging in the industry (Khan et al., 2017; Boesen et al., 2019; Salwa, 2019) thanks to its relevance to the closed-loop principle of Circular Economy (Dobrucka, 2019; Gong, 2019).

The development of bioplastics is apparent, research evolves to create desired characteristics for packaging (Sossa, et al. 2015; Khan, et al. 2017; Dobrucka, 2019). The bioplastic packaging characteristics found in the literature are grouped based on the material, manufacturing process, product performance, end of life and life cycle assessment (LCA). The bioplastic materials are derived from either fossil-based materials or renewable resources, and the recent development shows the increasing use of renewable resources (Boesen et al., 2019; Dobrucka, 2019; Khan et al., 2016; Theinsathid et al., 2009), such as the starch-based, polylactic acid (PLA) and which are currently more used for commercial than other bioplastic materials (Chadha, 2011; Dobrucka, 2019; Salwa et al., 2019). Alternative bioplastic materials are developing, such as cellulose-based, chitin-based, Polyhydroxyalkanoate (PHA), polyhydroxy-butyrate (PHB), Poly or 3-hydroxybutyrate-co-3-hydroxyvalerate (PHBV) (Salwa et al., 2019; Dobrucka, 2019). The production process is similar to that of conventional plastics (de Vargas Mores et al., 2018) but needs further development towards a more feasible cost (Theinsathid et al., 2009). Bioplastic packaging product performance includes similar features to conventional plastics (Khan et al., 2016), such as barrier properties, rigidity and hardness, rheological properties, strength, elongation, antistatic properties, printability, mechanical properties, heat resistance (Chadha, 2011; Dobrucka, 2019; Khan et al., 2016; Theinsathid et al., 2009). The end of life of bioplastic packaging includes recyclable, compostable and emphasises biodegradability (Ahmed et al., 2018; Boesen et al., 2019; Khan et al., 2016; Sarobol et al., 2013; Sossa et al., 2015; Theinsathid et al., 2009). Finally, bioplastic packaging is designed to have a better LCA, compared to conventional plastic (Leejarkpai, Mungcharoen, &

Suwanmanee, 2016; Sarobol et al., 2013; Theinsathid et al., 2009), that also considers competing land use in food production as food is an essential component in bioplastics along with health and safety considerations (Kuzincow & Ganczewski, 2015)

The literature, however, pinpointed that not all of the characteristics of bioplastics have been fully understood and there are differing (and somewhat contradictory) findings regarding a particular characteristic. For example, PLA has good rigidity, water vapour and gas barrier (Ahmed et al., 2018; Leejarkpai et al., 2016) while starch-based bioplastics are lacking in these (Khan et al., 2016). Not only may different sources of material lead to different characteristics, but the same sources of material may also indicate different specific characteristics, for example PLA. Some studies showed that PLA is known for its good mechanical properties (Ahmed et al., 2018; Khan et al., 2016; Leejarkpai et al., 2016) while other studies claimed that PLA has low mechanical properties (e.g. Theinsathid et al. 2009). These limitations impact on bioplastics application in the packaging industry.

The problems in the application are related to the use of renewable material and its processing, product performance, biodegradability and the side effects of implementing sustainable management to achieve better LCA. First, changing the source of material from fossil-based to renewable impacts significantly on the overall manufacturing and supply chain. Bioplastic packaging is made from bio-polymers processed using the injection moulding, thermo-processes to obtain the desired shape, thickness, colour or other specification for packaging (Khan et al., 2016; Sossa et al., 2015). Subsequently, the packaging will be processed along with the main products, given an additional labelling, processed with secondary and tertiary packages, until it reaches the end users. The process in the supply chain currently follows the same process, using the same equipment as the conventional plastic packaging (de Vargas Mores et al., 2018; Sarobol et al., 2013). However, bioplastics require additional materials and techniques such as the application of plasticisers (Benetto et al., 2015; Khan et al., 2016; Sossa et al., 2015), so not all conventional plastic packaging production processes can be used for bioplastics.

Second, the bioplastic packaging product performance and quality often fall below those of conventional fossil-based plastics (Khan et al., 2016; Theinsathid et al., 2009). This means bioplastic packaging often does not meet the desired function, and therefore cannot be properly used for certain products (Chadha, 2011; Khan et al., 2016; Salwa et al., 2019), or needs adjustment for existing products (Theinsathid et al., 2009). As exemplified by the application for food packaging, bioplastic packaging must be able to protect and maintain the physical proper-ties of the food in order, including ensuring hygiene and safety (Salwa et al., 2019). The same characteristics of the conventional plastic should exist in the bioplastic packaging, such as barrier properties, meaning the bioplastics should be able to provide barriers to air, water or any other external environment. However, when using a starch-based packaging for fresh produce or bakery items, the lower water barrier causes water to permeate easily and fresh produce becomes dehydrated or dry, causing a shorter product shelf life (Khan et al., 2016). Similarly, the application of PLA as packaging is often compared to the PET used for water or cold drink bottles (Boesen et al., 2019; Razza et al., 2015; Sarobol et al., 2013), but PLA has limitations in its heat resistance and mechanical properties compared to conventional plastics (Theinsathid et al., 2009). Hence, the recent solution to improve these issues by adding a reinforcement agent or even utilising the nano-technology, and are being intensively studied (Salwa et al., 2019).

Third, biodegradability is one of the features that make bioplastics a promising substitute for conventional plastics (Ahmed et al., 2018; Khan et al., 2016; Sarobol et al., 2013). To achieve a maximum biodegradable advantage, the biodegradable plastic packaging needs further processing at the biodegradable facility and cannot be mixed with the recycling process. There are still problems at the after the use stage; for example, due to the fact that PLA packaging is physically similar to conventional plastics, i.e. PET, and bioplastics is likely to cause confusion during the recycling facility, thus risking the loss biodegradable benefits and adding contamination to the recycling process (Benetto et al., 2015).

Last, bioplastic packaging is expected to have a better LCA than conventional plastics and as an environmentally friendly product, it should therefore be processed following the environmental regulations, considering health and safety to humans and the environment (Khan et al., 2016; Kuzincow & Ganczewski, 2015). These complicated requirements affect all the supply chain, leading to a higher cost of production (Benetto et al., 2015). Furthermore, agricultural or farming processes, harvesting the raw material, and complexity of the manufacturing may further exacerbate the LCA and the environmental impacts (Razza et al., 2015).

In answering RQ1, we found that not all characteristics of bioplastic packaging have been well understood by the customers. This circumstance, at present, limits its application in the packaging industry, thus, corroborates a need for further research on how the bioplastic packaging manufacturers and the users (i.e. product manufacturers), should co-innovate in producing better, fit-for-purpose products so as to increase the uptake of bioplastic packaging. Bioplastic product development is ongoing and directed to improve the properties of bioplastics and improve product performance for a variety of applications in the industry, mostly the packaging industry. Intensive in R&D is undertaken to develop alternative materials or improve the properties of the existing bioplastic materials in the market, such as starch-based and PLA, through modification of material utilising the reinforcement agents and nanotechnology, meanwhile still working to achieve the more feasible cost of production.

5.2. Existing studies on co-innovation in bioplastic packaging product innovation

This section illustrates the findings regarding the studies of co-innovation in bioplastic packaging, which also address the second research question. The following analysis consists of trends around specific co-innovation in bioplastic packaging and expansion to fields of study relevant to that context, such as packaging, green product development and best practices of co-innovation in other industries that can enrich the synthesis of this research.

The evolution of co-innovation studies that are specific to bioplastics in a decade indicates the need of co-innovation in R&D instead of solely or internally doing the product development.

Before 2010, studies related to bioplastics and co-innovation were limited due to the indication that the bioplastic industry was far behind commercialisation (Theinsathid, 2009). One of the strategies suggested to drive innovation in this industry was by giving attention to the technology push and demand pull, and integrating economic feasibility through the open innovation practices among the supply chain member (Theinsathid, 2009). Next, signifying the expansion of plastic industry to bioplastics, Chadha (2011) urged the need of supplier-customer collaboration in order to learn the technical area, overcome competence lock-in and achieve radical eco-innovation. Furthermore, dyadic or network co-innovation at the pre-competitive stage would likely be successful (Kishna, 2017). A study illustrating an example of successful co-innovation in developing breakthrough bioplastic was identified, showing the involvement of the green plastic supply chain, sustainability-oriented strategy as a critical foundation for the operation (de Vargas Mores, 2018).

Studies in 2019 shows more attention for co-innovation in bioplastic but direction for future studies are yet prominent. Boesen et al. (2019) briefly mentioned that collaboration with the supplier helps improving the environmental aspects of bioplastic packaging and addressing the market pressure. A highly relevant case study to the aim of this study was found, illustrating a successful green plastic development in Brazil, by which an intensive co-innovation in R&D is the key to its success (de Vargas Mores et al., 2019; Junior et al., 2019). Interestingly, in association with the Circular Economy, UK Fast Moving Consumer Goods companies moving more towards developing plastic packaging to optimise the recycling system, and showing less support for bioplastic packaging due to cost, insufficient disposal infrastructure and disruption to existing recycling systems (Gong et al., 2019). Different suggestions for future studies were found, such as collaboration with the suppliers (Boesen et al., 2019), understanding initiatives and actions towards Circular Economy (Gong et al., 2019), and exploring knowledge creation that generate new sustainable capabilities (Junior et al., 2019). See also Supplementary data: sheet "6_Articles_in_Bioplastics".

Most of the existing studies of co-innovation in bioplastics packaging, either directly or indirectly, emphasises the inter-firm collaboration as a strategy for advancing product development, innovation and tackle the challenges in the application of bioplastic (Khan, et al., 2017; Kishna, et al., 2017; de Vargas Mores et al., 2018; Dobrucka, 2019, Junior et al., 2019). However, the existing co-innovation studies that are specific to bioplastics are case studies, all of which the context was highly specific to the green plastic project in Brazil (de Vargas Mores et al., 2019; Junior et al., 2019) that also provide limited details on how co-innovation addresses the development of bioplastic properties or achieve product fit for use in the packaging industry. This fact indicates the research gap that need addressing in the future studies.

Due to the above limitations, analysis was extended to explore the process and mechanism of co-innovation in different industries focusing on case studies that describe detailed best practices. Table 1 summarises the implementation of co-innovation in several industry sectors that need to be considered. Current study in the aeronautical manufacturing illustrated the network collaboration strategies successfully facilitates the maximum utilisation of resources, extensive access to data and operation and extend the capacity of research to achieve technological excellence (Pinilla et al., 2019). The aeronautics field relied on intensive R&D, involve high complexity in the supply chain, manufacturing and technology Pinilla et al. (2019), which has a quite strong relevance to co-innovation in bioplastics. Furthermore, González-Ciordia et al. (2019) illustrated the process of forensic metallurgical failure analysis towards the root cause for improving the newly designed equipment in automotive manufacturing. Working with this mechanism, the customer should give access to perform such detailed investigation at the real production setting, be open to share information about their need and expectation and possibly make adjustment at the customer's side (González-Ciordia, 2019), This study is highly relevant when co-innovation in bioplastic packaging have to address the root cause of lacking product performance and make improvement. Last, co-innovation studies in the packaging industry show how supplier successfully create innovative packaging that not only fit for use but also become the solution to customer's problem (Baraldi et al., 2014; Morgado, 2008; Slater, 2010). Albeit the current studies are limited, the studies in this field works in the same industry sector, hence are highly relevant to the address the current problems of the bioplastics packaging.

Table 1. Summary of co-innovation best practice from other industry sectors.

Industry sector	**Co-innovation**		**References**
	Area of implementation	**Process and mechanism**	
Manufacturing-aeronautics	Highly intensive R&D investment to develop product that meet the industry requirement, such as system complexity, high reliability demand, multi-domain characteristic, extremely long life cycles, valuable products.	Involving large network collaboration, consisting government, university, suppliers.	Pinilla et al. (2019)
Manufacturing-automotive	supplier involvement in R&D collaboration for a range of vehicle systems, such as body assembly, steering, braking systems, etc; often focused on the technical issues related to design; the development of specific alloys, machine equipment and production processes to meet the customer's requirements.	Mostly supplier-customer supplier collaboration, focus on R&D collaboration at early stage. Engagement start from the partner selection process; the existing of suppliers pyramid. Transfer product-related knowledge, detailed investigation towards failure as the basis of new design improvement, access to real production setting, support customer's technology legitimacy	Croom (2001); Huber et al. (2011); Jeong and Ko (2016); González-Ciordia et al. (2019)
Manufacturing - packaging	Packaging development based on solution to customer's needs/problems, additional support services	Supplier-customer collaboration from conception to commercialisation, the supplier commits to continuous supply, takes role as business consultant; co-location to customer's site; promote customer's innovation; sharing sensitive/confidential information.	Baraldi et al. (2014); Morgado (2008); Slater (2010)

Furthermore, themes emerged through a careful data extraction of the existing studies. The literature in the bioplastics, green plastic product category explains that collaboration exists mostly between customer and supplier (Baraldi et al., 2014; Chadha, 2011; Farrow et al., 2000; Morgado, 2008), especially in R&D (Ahmed et al., 2018; Jeong & Ko, 2016) and co-development of a new product (Theinsathid et al., 2009). The literature in the bioplastics context argues that collaboration at the early stage of product development will increase the chance of successful product development (Theinsathid et al., 2009). In bioplastics co-innovation, learning, exchanging knowledge and absorbing partners' capability all occur when suppliers learn to understand the customers' needs and customers learn about the bioplastics technology (Jeong & Ko, 2016; Kishna et al., 2017; Theinsathid et al., 2009). In the case when customers are the final product industry leader, alliance strategies are involved which aim for maximum future competitive advantage, such as building their own bioplastics production (Jeong & Ko, 2016), establishing a standard of bioplastic packaging use for the industry and achieving technology legitimacy (Kishna et al., 2017). However, detailed discussion on the process of co-innovation in product development, and in particular bioplastic packaging, are limited since the data are collected from secondary sources (Jeong & Ko, 2016; Kishna et al., 2017). These findings answer RQ2 and subsequently pin-point *the research gaps* that need addressing.

5.3. *Co-innovation between organisations: from the development towards the final product*

5.3.1. The process of co-innovation

The co-innovation process describes a series of steps carried out in a specific order to achieve results, which in the context of the literature review is bioplastic packaging product innovation. Due to the limitations of specific references to bioplastic packaging, the analysis of the co-innovation process refers to co-innovation in the general packaging and sustainable product industry. The literature in the general packaging context is considered due to the similarity of product functionality, value chain, production and supply chain (Ahmed et al., 2018; de Vargas Mores et al., 2018; Khan et al., 2016; Sarobol et al., 2013), while the literature in the sustainable or product innovation context is highly relevant to the environmental aspects, new technology involved and emerging new markets (Chadha, 2011; Dobrucka, 2019; Melander, 2017).

The literature, especially on sustainable product innovation, reveals the stages of the collaboration and product development, which are important to allow exploration of the systematic process, and the importance of each stage to achieve bioplastic packaging product performance and sustainability performance. Based on the references, the stages of collaboration refer to the general collaboration for the product development process. In particular, sustainable product innovation involves positive sustainable or environmental impact at every stage (Lacoste, 2016; Soylu & Dumville, 2011), or at least one stage (Lee & Kim, 2011). The initial stage is the partnership development stage that exists before the product conception starts. In this stage, partners align their shared vision, value, objectives on sustainability, set goals and strategies, and establish commitment and contracts (Bossink, 2002; Oinonen & Jalkala, 2015; Perez et al., 2013). Partner selection considers the partner sustainable portfolio, technology and knowledge in sustainable areas (Melander, 2018), reviewing the partner's management policy in sustainability (Morgado, 2008) and environmental audit (de Vargas Mores et al., 2018)

After establishing a partnership, the partners enter the concept development stage. In this stage, customer and supplier engage in interactive ideation (Oinonen & Jalkala, 2015) to formulate novel product concepts (Rai, Pedersen, & Kazakeviciute, 2010), share knowledge and learn in a reciprocal way (Perez et al., 2013). During product conception, a joint project or specialised department is necessary (Bossink, 2002) involving skilled human resources in the area of sustainability (Abdullah et al., 2016), who will necessarily work in a high confidentiality environment (Morgado, 2008). At the concept development stage, product design should include sustainable features, functionality and material (Lacoste, 2016). Next, the product development stage consists of constructing product, raw material selection, developing a prototype, user testing and validation, and customers putting more resources into investment (Lacoste, 2016; Perez et al., 2013; Rai et al., 2010). The following stage is the implementation in the real production process (Bossink, 2002; Lacoste, 2016; Rai et al., 2010) and is followed by commercialisation (Oinonen & Jalkala, 2015).

Furthermore, the concept development stage is defined as the early product development stage, while the prototype development and product validation is the later stage (Melander, 2018). Supplier-customer collaboration timing varies from concept to prototyping stage (Lee & Kim, 2011), but the references emphasise the importance of early stage collaboration allowing the supplier to incorporate the customer's needs, improve the use of sustainable material, develop better offerings and increase customer contribution to the knowledge of product functionality, end of life (Lacoste, 2016), health and safety (Arnold, 2017), and clarify the need for particular sustainable product features, ideas for product concept and market information (Melander, 2018). Meanwhile, customer involvement at the later stage is also critical in product testing and validation (Melander, 2018) to increase product acceptance during commercialisation.

Similarly, the literature on general packaging reveals that the supplier-customer co-innovation process starts with the conceptual phase (Slater, 2010), in which supplier involved the customer in designing and engineering the product (Morgado, 2008), and continues with product development or prototyping phase and trials (Morgado, 2008; Slater, 2010) to commercialisation (Slater, 2010). They also disclosed a prominent factor facilitating the success in the collaboration process, that is when the supplier prioritises the customer's needs then provides solutions through innovation and integrated services (Baraldi et al., 2014; Morgado, 2008; Slater, 2010). Consequently, the collaboration promotes the customer's innovation (Morgado, 2008), increased the customer's strategic competitiveness and, in the end, led to close engagement and a long-term relationship (Slater, 2010).

Morgado (2008) explains the co-innovation and co-creation in the case of a leading plastic packaging company in Portugal, which includes product innovation with a significant improvement in the product function, both technical and use. In this collaboration, the supplier co-located to the customer's plant, insisted on the sharing of confidential information and taking on the role of business consultant. The supplier is highly competent and a leader in the packaging industry that is able to fulfil the client's need for innovative product with lower cost (Morgado, 2008). Likewise, Slater (2010) revealed that the packaging supplier committed to a continuous supply by sharing confidential demand information, then implemented a computerised integrated inventory program for the customer that include training during its implementation (Slater, 2010). In both studies, the suppliers immerse their activities complementary to the customer's value chain (Baraldi et al., 2014; Morgado, 2008; Slater, 2010). As a result, the collaboration contributed to the customer's improved manufacturing, just in time delivery (Morgado, 2008) or even won a product innovation award (Slater, 2010).

5.4.1. The mechanisms of co-innovation

Due to the limitations is specific reference in bioplastic packaging, the analysis of the co-innovation mechanism in this section has been inferred from co-innovation in the general packaging and sustainable product. The term 'mechanism' is referred to as a way of doing co-innovation that is influenced by factors such as drivers and success factors in a system, and the articles being reviewed pointed out three prominent themes: *joint activities* and *joint resources*, supported by the strong *relationship management* at both strategic and operation levels. Joint activities refer to interactive, reciprocal, pro-active activities with business partners to achieve the objectives of the collaboration. Joint resources include tangible and intangible resources committed to and invested in by all partners involved in the collaboration. Relationship management with business partners aims to build a productive relationship through activities, behaviours, knowledge and skills.

a. Sustainable oriented relationship management

Relationship management is important in sustainable product innovation; it also shares factors similar to collaboration in general, such as: trust, open communication, constructive coordination (Huber et al., 2011; Revilla & Knoppen, 2015; Yang et al., 2015), engagement (Croom, 2001; Tomlinson & Fai, 2013), conflict management, clear expectation (Lager & Frishammar, 2010; Tsou et al., 2015), contract agreement (Bossink, 2002; Greer & Lei, 2012), and power balance (Bossink, 2002; Huber et al., 2011).

The specific features in the sustainable product innovation context include, first, selection of a partner who possesses an innovative capability (Farrow et al., 2000) and complementary know-how in the environmental sustainability areas (Baraldi et al., 2014; Chadha, 2011), possibly confirmed through an environmental certification (Cheung, Myers, & Mentzer, 2010; Melander, 2017). Secondly, the customers and suppliers are often the problem solver types who are concerned with sustainability or environmental issues (Hofmann, Theyel, & Wood, 2012). However, the motivation towards sustainability may become a challenge in this instance when there is a doubt as to whether the customer or supplier is genuinely concerned with sustainability-related problems or they are merely compelled by regulations (Arnold, 2017).

Several factors are considered critical in developing the collaboration: a strong binding is related to joint investment in distinct activities or other resources (Cheung et al., 2010); and flexibility, tolerance and agreement to common standards instead of complicated detailed standards to resolve technological or other uncertainties (Fadhilah & Andriyansah, 2017; Melander, 2017; de Medeiros & Ribeiro, 2013). The collaboration should be built within a strategically close relationship (Lee & Kim, 2011) towards a synergy to improve value creation, address problems in bioplastics (Chadha, 2011), and thus lead to sustainable production and consumption.

b. Joint activities through transfer knowledge and co-creation

The collaboration between customers and suppliers involves activities that are carried out jointly and reciprocally, by integrating sustainability principles (Chen et al., 2017), and the interactions are emphasised at supporting the customer innovation (Farrow, 2000). The literature shows the activities jointly performed by customers and suppliers are mostly related to transfer knowledge and co-creation.

Knowledge transfer is achieved through continuous learning, knowledge sharing and exploration of new knowledge. Continuous learning includes acquisition, assimilation of diverse knowledge to innovate and development of novel technology (Chadha, 2011) in knowledge sharing routines (Hofmann et al., 2012; Huber et al., 2011). The customer and supplier share information and knowledge in order to explore new technologies, cutting edge manufacturing and product technologies (Dangelico, 2016). They also involve in R&D activities and learn specific technical needs and requirements (Chadha, 2011). Both customer and supplier monitor emerging technology and regulation in bioplastics, which may change the business environment and affect their investment and operation (Chadha, 2011).

Co-creation activities commonly found in different contexts of collaboration (Lee et al., 2012; Rai et al., 2010; Saarijärvi, Kannan, & Kuusela, 2013) including packaging (Morgado, 2008) and sustainable product innovation (Arnold, 2017; Lacoste, 2016). Co-creation is a process of creating tangible or intangible values, such as experiences, products, services, processes, etc., through the cooperation of stakeholders (Bharti, Agrawal, & Sharma, 2015; Ehlen et al., 2017; Rai et al., 2010). Supplier-customer co-creation activities create desirable outcomes in sustainable or green product innovation (Fadhilah & Andriyansah, 2017) by emphasising the understanding of customers' behaviour, which means matching their needs, and receiving feedback from customers (Oinonen & Jalkala, 2015), market information (Fang, Lee, & Yang, 2015), increasing the awareness and acceptance of sustainable product (Arnold, 2017), influencing customers' behaviour and adaptation towards the sustainable offering (Lacoste, 2016), and also involving the customers in the product development process (Fang et al., 2015).

c. Joint resources in product development

Collaboration in sustainable product innovation is beyond the transactional buyer-seller relationships. In contributing to a fruitful and lasting relationship, all members of the collaboration share tangible and intangible resources. The essential resources shared in the sustainability context are environmental knowledge and technology (Dangelico, 2016; Lee & Kim, 2011; Melander, 2018) which are jointly shared between firms, or flow from the external to the internal partner. In addition, collaboration may require joint investments (Baraldi et al., 2014) focusing on the product development project, such as infrastructure (Chen et al., 2017; Cheung et al., 2010), dedicated production unit (Morgado, 2008), and research facilities and equipment, human resource training & development related to environmental management and knowledge (de Medeiros & Ribeiro, 2013). Sharing resources facilitates a stronger relationship, learning, competence lock-in and minimises negative behaviour (Cheung et al., 2010). An example from a case study of supplier-customer collaboration in plastic packaging product development revealed that the supplier dedicated a production facility, a co-location that created interdependencies with the customer (Baraldi et al., 2014; Morgado, 2008).

In answering RQ3, we found that the process and mechanism of co-innovation are often viewed from the general packaging and sustainable product innovation contexts, revealing the stages of new product development and the mechanism, comprising *relationship management*, *joint activities* and *joint resources*. The literature in the general packaging context emphasises high responsiveness to customers' specifications and integrated services for the customers; while the sustainable product innovation context includes environmental and technological know-how, and sustainable processes throughout the value chain for better LCA. Co-innovation in bioplastic packaging requires a comprehensive process and mechanism that encompasses both product improvement and sustainability practices; however, the existing studies provide limited detail about these.

5.5. Towards an advanced bioplastic packaging as the outcomes of co-innovation

The importance of co-innovation for developing bioplastics and sustainable products has been highlighted in previous research and the following section explains the benefits and positive outcomes derived. The literature described how co-innovation is adding value to the final product by being recognised as an eco-friendly product and reducing cost as a result of integrating the supply chain (de Vargas Mores et al., 2018; Farrow et al., 2000). Co-innovation has been proven to enhance the overall corporate performance (Baraldi et al., 2014; Dangelico, 2016; Farrow et al., 2000; Morgado, 2008), especially financial performance (Arnold, 2017; Dangelico, 2016; de Vargas Mores et al., 2018; Morgado, 2008), product performance (Fadhilah & Andriyansah, 2017; Farrow et al., 2000; Lacoste, 2016), environmental performance (Arnold, 2017; Dangelico, 2016; Farrow et al., 2000; Lee & Kim, 2011; Soylu & Dumville, 2011) and innovation performance (Chadha, 2011; Slater, 2010). As a result from engaging in co-innovation with the customer, the supplier can increase its know-how in product development and may create a stronger interdependence with the customer (Baraldi et al., 2014)

From the literature in green product innovation context, several contributions are relevant to the bioplastic packaging characteristics, such as using fewer resources, having lower impacts on and risks to the environment, preventing waste generation at the conception stage, leading to a long-term higher quality of life, and improving environmental responsibility (Abdullah et al., 2016; Fadhilah & Andriyansah, 2017; Dangelico, 2016; de Medeiros et al., 2014). While from the literature in conventional packaging context, emphasis is on product performance, innovation and organisational performance, and less on environmental performance (Baraldi et al., 2014; Morgado, 2008; Slater, 2010).

Finally, the literature shows that the outcomes of co-innovation, which answer the fourth research question, are related to improving product quality and performance, reducing production costs, developing the organisation's capability and performance, decreasing the negative impact on the environment, promoting environmental responsibility and quality of life. Different outcomes emphasised between the references in the general packaging and sustainable product innovation literature, thus are insufficient to measure the outcomes of co-innovation in bioplastic packaging, which should incorporate both product functionality and environmental performance.

6. Discussion and synthesis

The first research question in this study seeks to understand the current state concerning the application of bioplastic packaging and the findings show inconsistencies between studies regarding characteristics, positive and negative aspects of the manufacturing processes, and use as packaging. Different characteristics are found across the material and within different applications of the same material, indicating the complexity of bioplastics technology (Benetto et al., 2015; Chadha, 2011; Khan et al., 2016; Razza et al., 2015). Having reviewed the current state of bioplastic packaging, it was apparent that there are issues in the application of the product from the bioplastic packaging manufacturer which mostly affect the product manufacturer as the direct user. The literature suggests that the manufacturing expertise in bioplastics packaging technology is currently lacking to ensure the full-scale production of bioplastic packaging, nor is it ready to establish bioplastics as a replacement for conventional plastic packaging. Therefore, involving product manufacturers in the product development through co-innovation is considered a promising strategy to enhance product development towards a better fit for users' needs. This is supported by the literature, in the packaging industry and sustainable product innovation context, which explicitly and implicitly specifies that co-innovation contributes, or is directly related, to product innovation (de Vargas Mores et al., 2018; de Medeiros et al., 2018; Fadhilah & Andriyansah, 2017; Dangelico, 2016; de Medeiros & Ribeiro, 2013, Slater, 2010; Morgado, 2008), thus supporting the need for co-innovation in bioplastic packaging product development.

6.1. Indicators for co-innovation performance in the bioplastic packaging context

A significant effort and resources dedicated to the co-innovation process should be directed towards a measurable targeted output or performance. Indicators based on the unique characteristics of bioplastics product are important to measure the intended performance of its development; however, the existing literature has not addressed this. Therefore, this study addresses this gap by initiating the development of comprehensive indicators for bioplastic packaging product innovation, as seen in Table 2, that includes product quality, sustainability, cost and innovation performance.

Table 2 - Proposed indicators of bioplastic packaging product innovation

Indicators	Sub-indicators	References
Product quality	Meets customer specification, comparable to fossil-based plastic or improved use, functionality, performance, aesthetic, eco-friendly image.	de Vargas Mores et al. (2018); Farrow et al. (2000); Fadhilah & Andriyansah (2017); Lacoste (2016)
Sustainability	Cyclic: using renewable resources and biodegradable, efficient use of renewable resources, less material footprint, environmentally friendly design product development and production process, minimum polluted residue after biodegradable process, alternative waste reduction process, recycling, reuse, etc.	Farrow et al. (2000); Lee & Kim (2011); Abdullah et al. (2016)
Cost	Efficient cost of production	de Vargas Mores et al. (2018), Farrow et al. (2000)
Innovation	Incremental or radical innovation.	de Propris (2002); Farrow et al. (2000); Dangelico (2016)

First on the table are the product quality indicators, initially developed based on Garvin's (1984) study comprising performance, feature, reliability, conformance, durability, aesthetic and perceived quality. In order to define the specific characteristics of bioplastics and sustainable products, the proposed indicators for bioplastic packaging include eco-friendly final product image (de Vargas Mores et al., 2018), appearance of natural-featured products (Fadhilah & Andriyansah, 2017), high performance, great looks (Farrow et al., 2000), improved use and functionality (Lacoste, 2016).

Secondly, the sustainability indicators in this study adopts the cyclic principle in the sustainable packaging principles developed by Verghese et al. (2012), which considers the use of renewable materials and recoverability at end-of-life. The proposed cyclic indicator refers to the biodegradability and use of renewable resources to address the importance of biodegradability in bioplastics as a solution to the solid waste problems. It also promotes changes to renewable material to reduce the dependence upon fossil-based material in conventional plastic packaging, thus, corroborates the closed-loop principle in the circular economy.

The next two indicators are related to cost and innovation, which are developed based on the recurring patterns from the literature. The cost indicators are used to present the efficiency and cost of production (de Vargas Mores et al., 2018; Farrow et al., 2000), which can become an important target of co-innovation due to the customer and end user sensitivity to price. Lastly, the innovation indicators adopt the incremental or radical innovation indicated by the creation of a new or improved product or process (de Propris, 2002) or recipient of official recognitions in the field of environment or sustainability (Dangelico, 2016).

6.2. The process of co-innovation

The findings of the literature review reveal that the co-innovation process occurs throughout all stages of product development, from the concept development and product development through to packaging production, ready for implementation in mass production. The timing to start the collaboration may vary from case to case. The literature revealed that there are clear benefits of starting the collaboration at different stages of product development, with regard to the different dynamics of the joint resources, joint activities and relationship management.

The dynamics of supplier-customer in co-innovation embrace active interactions through which customer and supplier's roles contribute to the process. In the concept development stage, the supplier, as the knowledgeable partner in bioplastic packaging technology, communicates their ideas about sustainability at the early, conceptual stage, and builds an understanding with the customer about the feature of the new product (Melander, 2018; Morgado, 2008). On the other hand, the customer gives information on and understanding about the product features and specifications needed (Melander, 2018). This is supported in the relational view, that partners provide sources of ideas for innovation and absorptive capacity increases the exploitation of knowledge (Dyer & Singh, 1998) into enriching the product concept, design and the concept development stage performance.

At the next stage, the product development phase includes product construction, raw material selection, prototype development, product testing and validation activities (Lacoste, 2016; Perez et al., 2013; Rai et al., 2010). Each customer or supplier will decide to add more investment to the activities or resources considering the extent to which the co-innovation would further support each partner's interest. In the product development, detailed work, technology and knowledge are more intensively dedicated to creating a product prototype. The supplier provides the new materials, design and technology used in the prototype, by considering the environmental management (Melander, 2018; Morgado, 2008). In the product development stage, more R&D expertise, skills and facilities are needed, and a greater contribution from each partner is likely to overcome any problems during prototype building. In the user testing stage, the customer plays an important role in small scope trials or larger pilot projects in order to check and validate if the product is fit for implementation on a mass production scale (Melander, 2018). In this stage, both partners learn from errors and contribute to the improvements.

6.3. Mechanism of co-innovation in bioplastic packaging product development

Having identified the indicators of successful co-innovation, a systematic mechanism of collaboration between customer and supplier should be devised in order to achieve successful co-innovation. However, limited studies reveal how to work on the product development mechanism through co-innovation, as most of the literature on bioplastics, including in the packaging industry, is focused on bioplastics engineering, technology, supply chain and in a general context (Benetto et al., 2015; Chadha, 2011; Dobrucka, 2019; Jeong & Ko, 2016; Kishna et al., 2017; Morgado, 2008; Theinsathid et al., 2009). For example, a study in bioplastics co-innovation is a case study in the car manufacturing industry (Jeong & Ko, 2016) showing the importance of an alliance portfolio for promoting product innovation; however, this study does not discuss how the mechanism of collaboration is able to improve the biodegradability, increase the use of renewable resources, or other characteristics of bioplastics product. Therefore, this corroborates the need for further study to fill the gap in order to contribute to understanding how co-innovation should be implemented to address problems related to its application as packaging and to create greater organisation capabilities.

6.3.1. Mapping the themes of the co-innovation mechanism to the theory

This study unveils the mechanism of co-innovation lies in the joint activities, joint resources and relationship management between supplier and customer. This is in accordance with the concept of co-innovation related to synergising various internal and external ideas, actions and resources to create new value that is difficult to be imitated by competitors (Baldwin & von Hippel, 2011; Bitzer & Bijman, 2015; Lee et al., 2012). This section explains the mapping of the themes regarding the mechanism to achieve the bioplastic packaging product innovation using concepts both in relational and absorptive capacity theory. These themes are mapped according to the sources of relational rent and mechanisms to preserve profits in the relational view (RV) (Dyer & Singh, 1998) and dimensions of the absorptive capacity theory (ACap) (Zahra & George, 2002). Figure 8 shows the 'joint activities', 'joint resources' and 'relationship management' themes and subthemes mapped into categories according to the concepts of both theories.

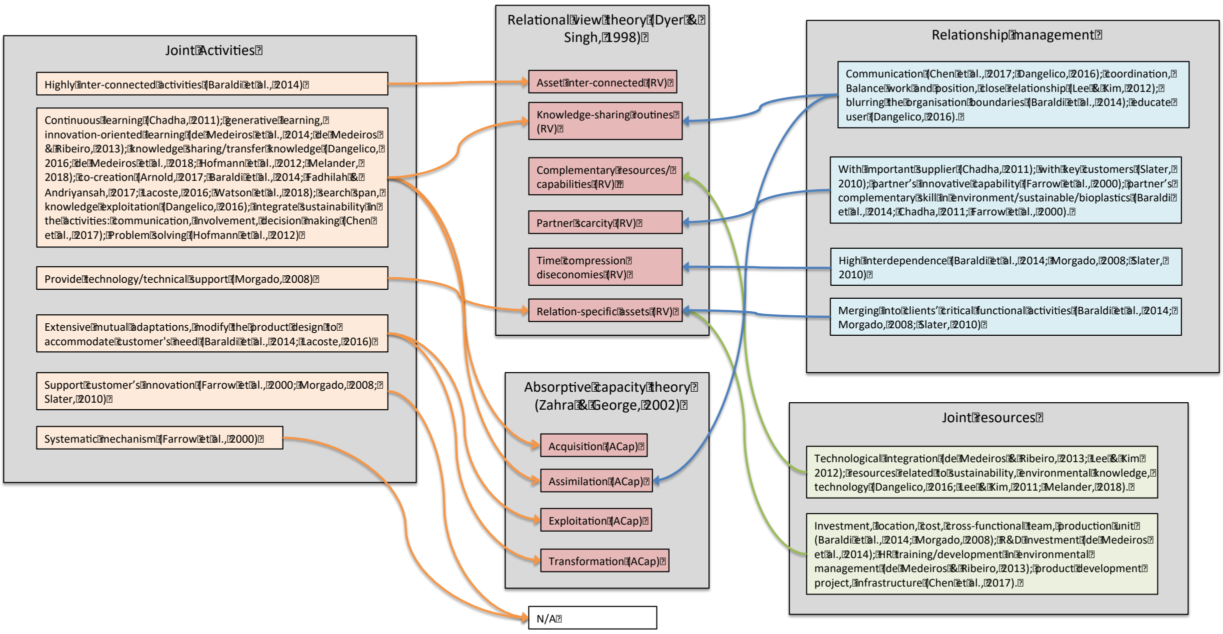

Figure 8. Mapping themes and sub-themes into the theory

Using the relational view theory (Dyer & Singh, 1998) and the absorptive capacity theory (Zahra & George, 2002), co-innovation between customer and supplier is enabled by the integration of complementary resources and knowledge to create greater benefits that cannot be achieved individually. If a bioplastic packaging manufacturer can improve the resources and capabilities to overcome the problems in the application that many of its competitors cannot, then a competitive advantage can be achieved. Without co-innovation in the bioplastic packaging product development, the packaging manufacturer, while having a valuable expertise in bioplastics yet lacking a fundamental understanding of its application to the product, may not in the end be able to market the packaging. On the other hand, product manufacturers will find it less feasible to build a bioplastic packaging production unit due to lacking capabilities in this field (Lee & Kim, 2011).

The outcomes of co-innovation in this study refer to the bioplastic packaging product innovation, which are measured by the indicators comprising product quality, sustainability, cost and innovation. This is aligned with the previous studies (Cheung et al., 2010; Murovec & Prodan, 2009; Tavani et al., 2014) that indicate the role of absorptive capacity and collaborative innovation towards product innovation capability and new product innovation.

6.3.2. Joint activities, joint resources, relationship management for bioplastic packaging product development

Customer and supplier are involved in reciprocal activities to develop new product in the collaboration. The relational view explains the source of relational rent from the interaction of partners to enhance the transfer of knowledge or the creation of specialised knowledge, as the knowledge-sharing routines (Dyer & Singh, 1998). The "Joint Activities" theme in the findings highlights the reciprocal interactions of customer and supplier in continuous innovation-oriented learning (Chadha, 2011; de Medeiros & Ribeiro, 2013); gathering and processing complementary information from each partner, such as the new bioplastics technology and manufacturing, industry and regulation, the application of packaging in the product, expected function from each type of packaging, all create a new combined knowledge that will contribute to product development success. Learning should be routinised in the knowledge sharing activities (Dangelico, 2016; de Medeiros et al., 2018; Hofmann et al., 2012; Melander, 2018) to increase the creation of valuable information and know-how that will also increase the product innovation capability. Besides learning, communication, involvement, decision making (Chen et al., 2017) and problem solving (Hofmann et al., 2012) should be integrated in sustainability practice to contribute to the sustainability performance in the bioplastic packaging product indicators. The association of joint activities and performance is represented by the following proposition:

> ***Proposition 1.*** *In the bioplastic packaging co-innovation context, higher supplier-customer joint activities will increase the success of bioplastic packaging product innovation outcomes.*

The customer and supplier contribute both tangible and intangible resources and capabilities to the collaboration, in which the relational view defines as the relation-specific assets (Dyer & Singh, 1998). Resources needed in co-innovation are for instance location, cost, cross-functional team, production unit (Baraldi et al., 2014; Morgado, 2008), special product development project (Chen et al., 2017), R&D investment (de Medeiros et al., 2014), provision of HR training in environmental management (de Medeiros & Ribeiro, 2013) and other infrastructures (Chen et al., 2017). By sharing resources, the customer can use the supplier's resources and capabilities related to bioplastics or the sustainability field, such as environmental knowledge, technology (Dangelico, 2016; Lee & Kim, 2011; Melander, 2018), and the supplier can use the customer's location, or production facilities (Morgado, 2008). The complementary resources and capabilities which are combined together will become a source of greater outcome (Dyer & Singh, 1998), such as increased productivity of individual resources, knowledge transfer, reduced cost and subsequently increase the success of product development. This is postulated by the following proposition:

> ***Proposition 2.*** *In the bioplastic packaging co-innovation context, higher supplier-customer joint resources will increase the success of bioplastic packaging product innovation outcomes.*

Maintaining and developing a fruitful collaboration requires a relationship management that includes partner selection, goal alignment and dialogue (Arnold, 2017). Partner selection, with important suppliers (Chadha, 2011) or key customers (Slater, 2010), is also important in relationship management (Melander, 2018), emphasising the complementary innovation capabilities (Farrow et al., 2000), environmental skills and expertise (Baraldi et al., 2014; Chadha, 2011) confirmed through environment audit or certification (Cheung et al., 2010; Melander, 2017). A compatible partner with complementary capability will contribute to the heterogeneity of resources that benefit the quality of input in the product development and learning. Communication (Chen et al., 2017; Dangelico, 2016), coordination, balancing work and position (Lee & Kim, 2012), lessening the organisation boundaries (Baraldi et al., 2014) and building a close relationship (Lee & Kim, 2012) will promote effective and productive activities, reconciliation and problem solving (Lacoste, 2016; Melander, 2018), therefore are likely to achieve bioplastic packaging product innovation success.

> ***Proposition 3.*** *In the bioplastic packaging co-innovation context, higher supplier-customer relationship management will increase the success of bioplastic packaging product innovation outcomes.*

The importance of relationship management in co-innovation not only influences the product output, but also the input dedicated to the collaboration (Melander, 2018), referred to as joint activities and joint resources in this study. Selecting the right partner allows good communication and coordination that will grow the involvement beyond only sharing knowledge and learning, for example, joint problem solving. Through close coordination in day-to-day activities, and solving problems in the process, both consumer and supplier build a stronger relationship, trust and initiatives for problem solving that lead to an increase in resources dedicated to the success of the collaboration.

Proposition 4. *In the bioplastic packaging co-innovation context, the higher the relationship management, the higher the joint activities dedicated to co-innovation.*

Proposition 5. *In the bioplastic packaging co-innovation context, the higher the relationship management, the higher the joint resources dedicated to the collaboration.*

6.3.3. Strong interdependence between supplier and customer

The relational view explains how the benefits from collaboration can be earned from creating causal ambiguity and time compression diseconomies (Dyer & Singh, 1998) such as trust, close relationship, dependency and specific capacity. Activities dedicated to the collaboration, such as solving a customer's problem, provide training for the customer's employees, move to the customer's location, and provide technical support, share market information, sales and end user's complaints with the supplier; blurring organisation boundaries in communication and coordination will lead to a strong relationship and high interdependence (Baraldi et al., 2014; Morgado, 2008; Slater, 2010). Assets dedicated to the collaboration, such as sharing facilities, infrastructure, dedicated team and other resources, will accumulate and create interconnected assets (Baraldi et al., 2014; Dyer & Singh, 1998), specialised in bioplastic packaging production, or possibly expand for greater use in the future.

Proposition 6. *In the bioplastic packaging co-innovation context, the higher the joint activities, the higher the supplier-customer interdependence, and therefore the bioplastic packaging product innovation outcomes.*

> ***Proposition 7.*** *In the bioplastic packaging co-innovation context, the higher the joint resources, the higher the supplier-customer interdependence, and therefore the bioplastic packaging product innovation outcomes.*

6.3.4. Promoting the customer's innovation motive underlying the co-innovation

The SLR finds that some cases emphasise that joint activities aim to promote customer's innovation (Farrow et al., 2000; Morgado, 2008; Slater, 2010), and customer's technology legitimacy (Jeong & Ko, 2016). Accordingly, supplier invests in resources for its customers to increase its success in developing breakthrough products (Perez et al., 2013). Supplier dedicates their expertise to solve the customer's problem, provide training for the customer's employees, move to the customer's location, and provide technical support, special teams and infrastructure. The more customer feels the supplier make a real contribution to innovation in the customer's company will lead to reciprocal action from the customer to give a greater contribution to the collaboration, willingness to share more information including confidential matter, and contribute a team, facility, infrastructure and other resources. These activities will accumulate and increase knowledge sharing routines, inter-firm learning, and form strong mutual dependence relationships and interconnected assets (Baraldi et al., 2014; Dyer & Singh, 1998). The following proposition adds that the motive to promote customer's innovation underlying the collaboration will contribute to the resource relation-specific assets represented in the joint resources and knowledge sharing routines represented in the joint activities.

> ***Proposition 8.*** *In the bioplastic packaging co-innovation context, the higher perceived contribution of supplier to customer's innovation, the more the customer responds more actively to the ongoing co-innovation, the higher supplier-customer interdependence and, therefore, the bioplastic packaging product innovation outcomes.*

6.3.5. The role of absorptive capacity in the mechanism

In the joint activities, customer and supplier reciprocal activities involve intensive transfer of knowledge or the creation of specialised knowledge (Dyer & Singh, 1998). In these activities, customer and supplier's absorptive capacity allows the acquisition of new valuable knowledge, then to assimilate, transform and exploit (Zahra & George, 2002) from the collaborating partner (Dyer &

Singh, 1998) to achieve bioplastic packaging product innovation. In the bioplastic packaging co-innovation, customer and supplier acknowledge and acquire valuable information from each partner (Dyer & Singh, 1998; Zahra & George, 2002) about the new bioplastics technology industry, environmental regulation, detail of packaging applications for the product, and the function of packaging for different products. Activities in the knowledge sharing should consider certain search spans that are relevant for exploitation (Dangelico, 2016) to contribute to the innovation indicators in the product.

Following that, the knowledge sharing routines (Dangelico, 2016; de Medeiros et al., 2018; Hofmann et al., 2012; Melander, 2018) embedded in the joint activities shall facilitate assimilation of new knowledge, which are then transformed into a new or more advanced knowledge that promotes customer and supplier actions, solutions, decisions, and adaptation applied to the product being developed. Adaptation can either be shown at the supplier side, such as learning about the customer's needs (Baraldi et al., 2014; Cheung et al., 2010) then accommodating these needs into the product design; or at the customer side, for instance, adapting the requested product specification to correspond to the supplier's offering (Lacoste, 2016). This process is likely to enrich the design, speed the development process and minimise correction at the user testing stage, thus contributing to a more effective product development process. Therefore, the previous studies claimed that the absorptive capacity will act as a strong predictor to the green innovation adoption (Aboelmaged & Hashem, 2019), and co-innovation towards performance, only in the existence of absorptive capacity (Tavani et al., 2014).

> ***Proposition 9.*** *In the bioplastic packaging co-innovation context, the absorptive capacity mediates the relationship between co-innovation and bioplastic packaging product innovation outcomes.*

The absorptive capacity increases after partners in the collaboration interact in communication, coordination, a strong engagement, trust, and openness, that allow an understanding of each partner's expertise and then use the specific expertise to solve problems or make significant improvements (Dyer & Singh, 1998). As in the relationship management theme, compatible partner (Chadha, 2011; Cheung et al., 2010; Melander, 2017; Slater, 2010), communication (Chen et al., 2017; Dangelico, 2016), coordination, and balancing work and position (Lee & Kim, 2012), lessen the organisation's boundaries (Baraldi et al., 2014) and build close relationships (Lee & Kim, 2012) that will increase the absorption capacity.

> ***Proposition 10.*** *In the bioplastic packaging co-innovation context, the stronger the relationship management, the higher the absorptive capacity and therefore bioplastic packaging product innovation outcomes.*

The proposed mechanism of the supplier-customer co-innovation for developing innovative bioplastics product is presented in Figure 9.

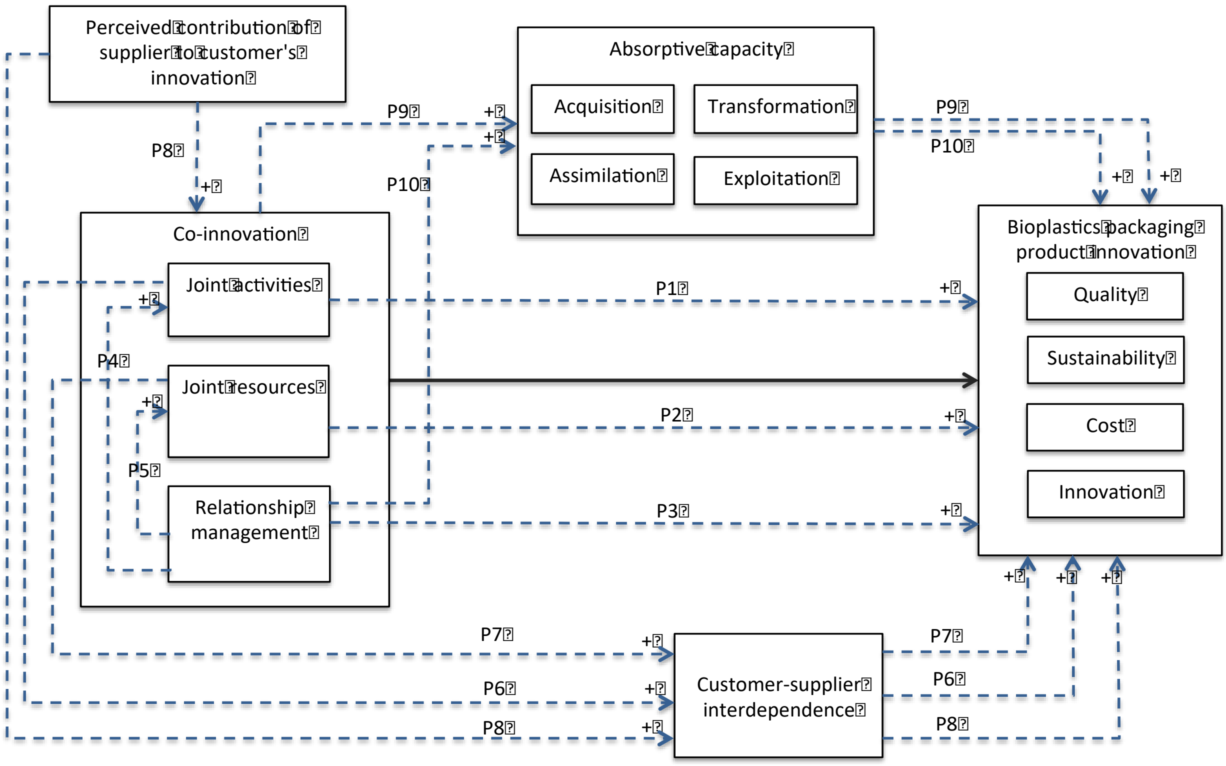

Figure 9 - The conceptual framework of the co-innovation mechanism

7. Conclusions

This research opens further understanding about the extent to which co-innovation is relevant to be applied in bioplastic packaging product innovation. Addressing the objectives of this study, we have come up with four conclusions:

- The current situation regarding bioplastic packaging indicates that there are problems where product manufacturers (OEMs) cannot immediately use packaging products produced by the manufacturers.

- The literature examining the work in co-innovation in the context of bioplastic packaging applications and product development is remarkably lacking.
- The thematic analysis demonstrates the co-innovation process and mechanisms through joint resources, joint activities and relationship management.
- The SLR reveals the positive outcomes of co-innovation in the form of product innovation, increased company innovative capabilities and corporate performance.

7.1. Implications

This study provides a valuable contribution by showing the research gaps for further investigation of co-innovation in bioplastic packaging due to the limited literature on co-innovation that is specific to bioplastic packaging, including how to solve the problems in bioplastic packaging application between the bioplastic packaging and product manufacturers. This study also extends the concept of co-innovation through joint activities and commitment to resources over innovation, and the innovation performance (de Propris, 2002) by adding clear mechanisms of joint activities and joint resources. The previous studies on the mechanism of co-innovation between buyer and supplier that successfully improved product performance and innovation (Baraldi et al., 2014; Morgado, 2008; Slater, 2010) have also been expanded in the proposed framework, by adding the sustainable management practices and performances as indicated by the literature on sustainable product development (Dangelico, 2016; Lee & Kim, 2011; Melander, 2017). The proposed framework, therefore, incorporates the outcomes of co-innovation indicated by both product and sustainable performances, which also promote the benefits of bioplastic packaging.

The framework also encompasses the mechanism of co-innovation between the customers and suppliers of bioplastic packaging, denoted by the relational view theory (Dyer & Singh, 1998) and absorptive capacity theory (Zahra & George, 2002), and subsequently extends several studies adopting both theories. Specifically, this study extends the work of Baraldi (2014), which adopted the relational view to see the supplier's perspective on outsourcing and proposed that value should be co-created with the customer via high mutual dependence. Co-innovation extends the scope of outsourcing into a more intensive supplier-customer collaboration, and through the proposed framework, a supplier-customer mutual dependence construct is developed by showing the joint activities and joint resources as the antecedents. Previous study by Cheung et al. (2010) indicated that the learning engaged in the buyer-supplier dyad is positively related to value creation and provide the indicators of relationship learning and value (Cheung et al., 2010). These indicators are also adopted in the proposed framework to increase the robustness of the co-innovation construct development and could be refined based on the bioplastic packaging context in the future study.

Another significant finding of this study is the relevance of the suppliers' contribution to assist customers to innovate. This finding reflects those of Perez et al. (2013) who argue that the higher the company's ability to interact and learn about its customers, the higher the likelihood that the company will invest resources for its customers so as to increase success in developing breakthrough products. This study applies the *perceived supplier's contribution to customer's innovation* construct that reflects the partnership development point or early conceptual stage, in which the supplier indicates an investment plan or positive efforts to accommodate customer needs. This concept provides a valuable insight into whether the motive to promote customer's innovation will contribute to the resource relation-specific assets (Dyer & Singh, 1998).

The proposed framework and indicators have important implications for promoting further collaboration in bioplastic packaging, and helping practitioners find new ways of developing breakthrough in bioplastics research and sustainable products through supplier-customer co-innovation. The expertise in bioplastics engineering involves a complex combination of skills and knowledge in bioplastics technology, engineering, and environmental management (Bossle, De Barcellos, & Vieira, 2016) and, thus, is a valuable organisation capability. Through co-innovation, this capability can be enhanced through learning about the customer's needs, improvement in the operations, stronger relationship with the customers and creating innovative product, thus creating a specialised expertise (Baraldi et al., 2014), overcoming environmental problems (Hofmann et al., 2012), and obtaining new knowledge (Melander, 2018). From the managerial perspective, these resources would greatly contribute to the organisation's competitive advantages.

7.2. Limitations and suggestions for future research

Despite the promising contributions to the bioplastic packaging industry, this study has several limitations. Under the relational view theory, the framework assumes that suppliers and customers developed a long-term relationship (Perez et al., 2013; Turkmen, 2013). Nonetheless, it is possible that the collaboration is designed for a short-term goal, e.g. until the desired bioplastic packaging is discovered, and then the relationship continues on a transactional basis. Although the SLR is more likely to minimise bias compared to a narrative review, by means of the rigorous methodology in the article search and inclusion, there is always a possibility that some relevant articles are not captured from the databases due to the rigid search strings, the choice of databases, or the filters employed in the search strategy of this SLR. Though the flexibility in the thematic analysis allows the researcher to capture patterns arising from the data extraction, this study purposely focuses on the patterns that are relevant to the aims of this SLR.

As bioplastics continues to grow and mature, the mechanism of supplier-customer co-innovation in bioplastic packaging will remain open to adjustment. Further investigation is needed to test and refine the proposed framework, by using case studies, direct observations or surveys, in order to shed more light on the mechanism of co-innovation based on its real-life context. As this study focuses on the bioplastic packaging product innovation context, indicated by problems in the product application and environmental/sustainability issues, the applications of the proposed framework in a different context thus need a careful thought.

Finally, the research gaps are quite obvious that co-innovation has not been much explored or justified for the bioplastic packaging industries, of which focus of the further studies should address co-innovation for improving bioplastics properties, product attribute and fit for use by the customer. Alternatively, further studies could to explore how inter-firm co-innovation is implemented in other cases, in other countries, the success factors for co-innovation to deliver the advanced bioplastic products as indicated in this study. More attention to the bioplastic application for packaging is needed considering highly potential application of bioplastic in this industry for replacing the conventional plastic packaging. Future studies need to explore primary data source of real-world practices and insights from practitioners in this field using primary data due to the limitation of the secondary in providing detailed view on the co-innovation mechanism and process.

Supplementary data:

Filename: JCLEPRO list of articles and database 1220final

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