# Modelling hierarchical circular supply chain management enablers in the seafood processing industry in Vietnam under uncertainties

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**Abstract**

This study establishes a valid set of circular supply chain management enablers in Vietnam under uncertainties. Circular supply chain management optimizes resource utilization and minimizes waste in achieving competitive advantage; however, prior studies failed to build enablers for industrial improvement under qualitative information. This study adopts the fuzzy Delphi method to arrive at a valid group of attributes. Fuzzy set theory deals with the uncertainties from qualitative data, and fuzzy interpretive structural modeling builds the hierarchical structure under uncertainties. The best-worst method confirms the consistencies. This study stipulates a four-level hierarchical structure in the seafood processing industry. The results show that organizational capability and agility, technological advancement and economic benefit are dominant aspects. Commitment of leadership and managerial support, suppliers' collaboration, firm culture, readiness for organizational change and sustainability concept integration are top criteria for industrial improvement.

**Keywords:** circular supply chain management enablers; triple bottom line; dynamic capability view; fuzzy set theory; interpretive structural modeling; best-worst method

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## 1. Introduction

In Vietnam, the seafood processing industry is important in providing foods for people, positively contributing to agricultural and rural economic structure transformation, dedicated to hunger eradication, poverty reduction, job creation and achieving export-import balance. However, this industry's rapid growth has caused sustainability concerns over the environment, such as pollution and waste (Alnajem et al., 2021; Poursoltan et al., 2021; Tseng et al., 2020). In particular, the high energy usage in seafood production generates increased air pollution. Wastewater and solid waste generally result from processing operations, and packaging waste is also a major concern. In this context, Farooque et al. (2019) indicated that circular supply chain management (CSCM) linking supply chain management with the circular economy's philosophy emerges as an appropriate solution requiring a thorough reform of the entire structure in both production processes and consumption activities. CSCM synchronizes forward and reverse supply chains to form value from products, secondary products, and appropriate waste flow by virtue of an extended life cycle (Batista et al., 2018). Consequently, adopting CSCM brings about numerous benefits such as improved resource availability, reduced waste generation, and better social benefits (Despeisse et al., 2017; Goyal et al., 2018). Hence, executing CSCM arises as an urgent requirement for the industry.

CSCM execution is driven by enablers that the industry must acknowledge. Enablers are attributes that ease CSCM adoption by firms. The triple bottom line (TBL) has been proven to benefit the supply chain environmentally, socially and economically; thus, it has been widely adopted in previous studies (Ahmed and Sarkar, 2019; Tseng et al., 2020; Wu et al., 2016). Integrating the TBL perspective to identify CSCM enablers is adequate, as the concept aims to enhance firms' sustainability (Batista et al., 2018; Farooque et al., 2019). In particular, the economic perspective focuses on achieving financial gains and future growth, while the environmental perspective requests firms to reduce their impacts on the environment. The social perspective refers to the full scope of responsibilities that firms have toward society. Furthermore, firms utilize the dynamic capability view for the purpose of adjusting to rapidly changing supply chain situations (Kumar et al., 2018; Chowdhury et al., 2019; Gupta et al., 2020). Dynamic capabilities are positively conducive to CSCM application (Khan et al., 2020). Firms are required to develop suitable capabilities and reconfigure resources for the supply chain's circularity objectives in agreement with the dynamic capability view (Chowdhury and Quaddus, 2017; Khan et al., 2021). Notably, leveraging technological development associated with organizational capability enables firms to execute CSCM and amplify performance (Aboelmaged, 2018; de Sousa Jabbour et al., 2018). Hence, the TBL perspective and dynamic capability view are embodied in this study.

In the literature, Aboelmaged (2018) indicated that organizational capability characterized by support from management and employee engagement provides the bond that guarantees sustainable manufacturing practices. de Sousa Jabbour et al. (2018) argued that when organizational capability is developed together with digital technologies, this unlocks resource circularity across supply chains, such as decreasing resource consumption, preventing excessive resource usage, diminishing waste production and monitoring products after consumption to recover constituents. Agyemang et al. (2019) suggested that economic motivation drives firms to apply CSCM initiatives to advance market share, increase profits and reduce costs. Munny et al. (2019) argued that firms are obligated to include social responsibility in the supply chain to alleviate stakeholder pressure. Bhatia et al. (2020) asserted that environmental management achieved by implementing CSCM needs to be one of the imperative agendas for firms. In sum, the integration of environmental management, economic motivation, social responsibility, technological development and organizational capability perspectives allows a complete approach to understanding the hierarchical structure.

To promote widespread CSCM execution, managers need to identify and understand the key enablers that need to be actualized. Despite efforts to lay a theoretical base for CSCM, prior studies failed to comprehensively determine crucial enablers and hierarchical structures for CSCM attributes (Agyemang et al., 2019; Govindan and Hasanagic, 2018; Bhatia et al., 2020). Hence, this study employed the hybrid method fuzzy interpretive structural modeling (FISM). The fuzzy Delphi method (FDM) is used to define valid and reliable CSCM enablers (Tseng et al., 2020). The attributes are usually measured in qualitative information. Fuzzy set theory is employed to defuzzify qualitative facts (Bui et al., 2020). FISM arranges attributes into a hierarchical structure (Tsai et al., 2020). Moreover, in the hierarchical structure, criteria weights are determined by adopting the best-worst method (BWM) (Rezaei, 2016). As a consequence, the study incorporates three objectives.

- To develop a group of CSCM enablers with qualitative information and linguistic preferences;
- To construct CSCM enablers' hierarchical structure under uncertainties;
- To present CSCM improvement enablers in practices.

The study's contributions comprise (1) providing a valid set of CSCM enablers via qualitative information evaluation; (2) determining the hierarchical structure among CSCM enablers in linguistic preferences; and (3) offering guidance and suggestions for the seafood processing industry. This study is structured as follows. Industry background for CSCM is offered in Section 2. Methodological interpretation is presented in Section 3. Section 4 reports the results, while Section 5 explains both theoretical implications and practical implications. Finally, Section 6 shows conclusions together with limitations and future studies.

## 2. Literature review

The theoretical framework and literature review on CSCM are shown in this section. Additionally, the method and measures are displayed.

### 2.1. Theoretical framework

The TBL perspective involves integrating essential pillars of sustainability with respect to the economy, society and environment (Elkington, 1998; Wu et al., 2016). The traditional prime aim of optimization plans and models employed in the strategic structure concentrated only on supply chains' economic attributes. However, Ahmed and Sarkar (2019) pointed out that there has been a feasible awareness connected with the supply chain's environmental concerns and social issues. While the firm's profit-making competence is acknowledged in economic motivation, social responsibility involves a firm's activities to assist stakeholders and society. Finally, environmental management is associated with a firm's environment-oriented activities throughout its operation (Tseng et al., 2020). The TBL perspective encourages a firm to simultaneously realize economic accomplishment, environmental management, and social equity. Firms' long-lasting survival progressively depends on sufficient TBL performance.

Dynamic capability is a firm's capacity to reform and transform its assets, resources and strategies in a changeable or unpredictable context (Teece et al., 1997; Chowdhury and Quaddus, 2017; Chowdhury et al., 2019). Kumar et al. (2018) emphasized that building dynamic capability is required to optimize sustainable performance in the TBL perspective because the degree of risk and uncertainty of the business setting is more intensified with CSCM than with traditional supply chain management. A clear organizational structure enables firms' operations to succeed in unanticipated market circumstances and supports internal capabilities. Firms wishing to gain a competitive advantage foster agility in operations, align with stakeholders, and more effectively apply new technologies in the supply chain (Gupta et al., 2020). Dynamic capabilities considerably smooth the way for CSCM implementation (Khan et al., 2020; Khan et al., 2021).

The TBL perspective is imperative for CSCM in strategic decision making since it allows a firm to pinpoint clear goals and identify indispensable enablers such as environmental management, economic motivation, and social responsibility (Alnajem et al., 2021; Govindan and Hasanagic, 2018; Agyemang et al., 2019; Tseng et al., 2020). However, TBL is insufficient to incorporate the ideas of sustainability along with a circular supply chain and must be considered from other perspectives (Wu et al., 2016; Choi and Chen, 2021). Affiliated with the dynamic capability view, technological development and organizational capability facilitate the transformation of operations' processes and CSCM execution (Aboelmaged, 2018; de Sousa Jabbour et al., 2018; Khan et al., 2021). These two theories supplement each other in clarifying CSCM enablers, as firms are driven to execute CSCM not only owing to environmental management, economic motivation, and social responsibility priorities under the TBL perspective but also by virtue of technological development and organizational capability under the dynamic capability view. Hence, this study integrates the TBL and dynamic capability view to identify influential enablers and hierarchical structures.

### 2.2. Circular supply chain management

Batista et al. (2018) conceptualized CSCM as the integration of forward and reverse supply chains to construct a firm's ecosystem alliance for value formulation and effective waste flows via extended life cycles, enhancing firms' sustainability in terms of TBL perspectives. CSCM encourages sustainability thinking by consistently employing circular economy thinking in all supply chain stages along with functions. Mangla et al. (2018) identified that CSCM is an appropriate solution to lessen contamination, an achievable goal relating to consumption and production, scarcity of resources, and climate change. Firms are able to decrease waste, improve the availability of resources, and benefit society by executing a circular supply chain in terms of products, material, and waste flow (Despeisse et al., 2017; Goyal et al., 2018). Farooque et al. (2019) indicated that CSCM exhibits an optimistic vision to enable firms to gain advanced performance regarding resource efficiency, and consequently, profitability and diminishes adverse environmental and social effects.

From an environmental management perspective, Sharma et al. (2016) argued that environmental motivation is one of the key drivers for remanufacturing to decrease waste, utilize resources and prolong the product lifecycle. Moktadir et al. (2018) noted the world's progressive consciousness of the environmental demand to establish a sustainable economy in the future. Firms are motivated to adopt a circular business model and be willing to reduce adverse environmental impacts (Nußholz, 2018; Poursoltan et al., 2021; Tura et al., 2019). Kristensen and Mosgaard (2020) proposed that resource efficiency is illustrated in 3Rs, including reducing, reusing, and recycling, with a focus on decreasing material input and bettering resource utilization. Singhal et al. (2020) stated that the CSCM application enables firms to use resources efficiently, which leads to increased value to society. Bhatia et al. (2020) clarified that attention to environmental issues such as poisonous waste generation and natural resource scarcity urges firms to execute CSCM.

From an economic motivation perspective, Vlajic et al. (2017) indicated that the potential of value recovery supports circular supply chain creation, as CSCM is often operationalized and understood with reference to circular flows, which carry value recovery operations. Bhanot et al. (2017) noted that firms adopting sustainable practices, in turn, realize economic benefits such as better product quality, increased market share, and higher profits. This adoption improves firms' image and market competitiveness and is crucial to sustainable production initiatives. Govindan and Bouzon (2018) clarified that economic benefit such as reducing raw material usage and waste treatment costs and recovering the remaining value from used products improves reverse logistics practices. De Jesus and Mendonça (2018) stated that decoupling revenue and improving resource performance are important economic drivers for powering the shift to a circular economy. Gusmerotti et al. (2019) suggested that economic benefits such as lower production costs are significant for implementing CSCM in manufacturing firms. Tura et al. (2019) found that cost savings and the potential to actualize value from waste incentivize firms to adopt CSCM. Bhatia et al. (2020) argued that the economic benefits of reducing raw material costs and disposal costs drive firms to adopt CSCM.

Social responsibility enables other sustainability initiatives, and ignoring this perspective leads to extremely adverse effects in the supply chain (Ahmadi et al., 2017). In connection with the social responsibility perspective, Jakhar et al. (2018) stated that firms feel pressure to adjust the full product life cycle to include sourcing, manufacturing, using, disposal and recovery of product value after its end-of-life as a result of the increased awareness (together with knowledge of stakeholders) about sustainability. Moktadir et al. (2018) noted the continuous escalation of customers' pressure to shift the linear model to a circular economy as customers become more conscious of environmental issues and look for environmentally friendly products. Furthermore, continuous pressures from stakeholders create demand for firms to adopt circular initiatives to fulfil corporate social responsibility, which encompasses a firm's relationship with and social impacts on the environment through its scope of effects (Agyemang et al., 2019; Walker et al., 2021).

Concerning the technological development perspective, technological advancement is a condition for adaptability in a rapidly fluctuating market; thus, CSCM development with appropriate technologies enables firms to enhance process safety, resource efficiency, and more intelligent and adjustable supply chain processes (De Jesus and Mendonça, 2018; Luthra and Mangla, 2018). Rajput and Singh (2019) determined that incorporating technological advancement supported by Industry 4.0 together with a circular economy brings about enhanced functional capacity, increased efficiency along with precision, and a more sustainable supply chain. Moktadir et al. (2020) emphasized that technological advancement facilitates CSCM implementation by improving resource use and reducing and recycling waste generated from operations. Bag et al. (2021) argued that technological advancement assists in increasing supply chain visibility and flexibility, improving operational performance, decreasing resources, and utilizing waste during the production stage, which enables CSCM.

Strong competition in the market, a dynamic environment and increasing customers' environmental awareness result in firms focusing on organizational capability to drive CSCM and enhance competitive advantage. Ansari et al. (2019) elucidated that the managerial enablers, especially with the support and involvement of top management, significantly affect the execution of remanufacturing initiatives in the supply chain. Ahuja et al. (2019) noted that employee-related is as equally important as other attributes, such as technology and supply chain initiatives, to implement sustainable manufacturing. Jabbour et al. (2019) highlighted that CSCM business models need solid support from human resources practices relating to top management commitment and employee engagement to trigger firms' sustainable performance. Furthermore, firms prioritize agile capability to cope with highly uncertain marketplace changes in a rapid manner to promote performance, attain high customer responsiveness, decrease costs, and increase profitability. Geyi et al. (2020) argued that agility acts as an enabler of sustainability performance and an essential prerequisite for maximizing the outcome of sustainability practices.

### 2.3. Proposed method

Govindan and Hasanagic (2018) utilized content analysis to categorize drivers affecting the supply chain framework's circular economy application. Govindan and Bouzon (2018) utilized a systematic approach based on a structured procedure to classify reverse logistics drivers. Tura et al. (2019) conducted semi-structured interviews to identify the drivers of the leading circular economy and examine how these drivers affect individual firms. These studies used qualitative approaches founded on a literature review analyzing CSCM enablers.

Prior studies also applied quantitative methods in studying CSCM, especially CSCM enablers. For instance, Sharma et al. (2016) used a questionnaire-founded survey with a five-point Likert scale to identify TBL drivers of remanufacturing. Moktadir et al. (2016) adopted a graph theory technique with a matrix method to evaluate, rank, and prioritize sustainable manufacturing and circular economy drivers. Partial least squares structural equation modeling was used to investigate drivers' influence on practices of sustainable manufacturing (Aboelmaged, 2018). Munny et al. (2019) employed the BWM for ranking social sustainability enablers. Ahuja et al. (2019) utilized a decision-making trial and evaluation laboratory (DEMATEL) to identify interrelationships among human factors for fulfilling sustainable manufacturing practices. Ansari et al. (2019) employed a hybrid method, including a fuzzy analytic hierarchy process for ranking key supply chain remanufacturing factors and a fuzzy technique for order performance by similarity to an ideal solution to give priority to performance outcomes as a result of their adoption. Agyemang et al. (2019) utilized a questionnaire survey to collect data to examine the circular economy's internal and external drivers. Bhatia et al. (2020) made use of a gray DEMATEL technique to investigate cause and effect relationships among drivers of closed-loop supply chain exertion.

Studies neglected to construct a hierarchical structure of attributes. Qualitative and quantitative attribute assessments in increasingly important areas motivate this study to use fuzzy set theory. Hence, this study employs the FISM method to build up the hierarchical structure of CSCM enablers. In particular, fuzzy set theory is used for handling problems connected with human judgment uncertainty in an uncertain environment (Bui et al., 2020). ISM is an adequate analysis tool to obtain the hierarchical structure of attributes (Tsai et al., 2020). Finally, BWM is utilized to grade the criteria in line with their importance (Rezaei, 2016). Figure 1 displays flowchart of methodology.

(INSERT Figure 1 here)

**2.4. Proposed measures**

This study suggests five perspectives for analyzing CSCM enablers, including environmental management, economic motivation, social responsibility, technological development, and organizational capability. Appendix 1 presents the original set of 55 criteria that was formerly suggested for the assessment procedure.

Environmental management (P1) facilitates long-term achievement and competitiveness (Tseng et al., 2021; Wu et al., 2016). Adopting circular supply chain management results in waste generation reduction (C1) (Bhatia et al., 2020). Remanufacturing contributes substantially to resource conservation (C2) and saves energy (C3) (Sharma et al., 2016). Resource scarcity (C4) is an influential enabler of sustainable manufacturing practices in a circular economy. The original reason for advancing the readiness to adopt a circular economy arises from the demand to decrease adverse environmental impacts (C5) (Tura et al., 2019). Climate changes (C6) occur due to the amount of waste and greenhouse gas emissions generated, accompanied by resource consumption (Govindan and Hasanagic, 2018).

Economic motivation (P2) shows the importance of the CSCM application. Current evolutions in the worldwide economic environment demand that firms reconstruct and reorganize to boost business, increase profits and sustain competitive ability in the marketplace (Lin and Tseng et al., 2016; Tseng et al., 2019). The capability of reducing product costs (C7) drives firms to deal with circular supply chains (Tura et al., 2019). Implementing CSCM advances long-term revenue generation (C8) by efficient recycling and remanufacturing activities (Govindan and Hasanagic, 2018). Sustainable manufacturing practices ensure competitive advantages (C9) for firms in the marketplace (Moktadir et al., 2018). Adopting a circular supply chain as a way to position firms to react to the market strengthens sustainable business and growth (C10) (Agyemang et al., 2019). The potential of value recovery (C11) brings an opportunity to adopt a circular supply chain (Vlajic et al., 2018). Firms with limited resources integrate remanufacturing and manufacturing operations (C12) to use their existing resources efficiently (Bhatia et al., 2020).

In addition to the firm's environmental management and economic motivation, social responsibility (P3) should be addressed when firms implement CSCM. Firms supplying healthy and safe working conditions (C13) and undertaking social welfare responsibility find enhanced support from employees to fulfill goals (Ansari et al., 2019). Wages and benefits (C14) involve suitable payment and related sustainable employment matters (Munny et al., 2019). Brand protection (C15) is an enabler of reverse logistics due to competition, and significant brand erosion requires resolution to perform reverse logistics (Govindan and Bouzon, 2018). Firms execute remanufacturing practices to reinforce their green image and reputation (C16) (Sharma et al., 2016). Suppliers' collaboration (C17) is a driver for a smooth pathway to a CSCM implementation (Moktadir et al., 2018). Government regulations and support (C18) are essential for adopting CSCM practices in firms. Customers' awareness (C19) of environmental protection creates pressure on firms to apply CSCM practices (Bhatia et al., 2020). Facing intense and radical competition (C20) in the environment, firms are motivated to perform CSCM, increasing their potential to realize competitive advantage (Agyemang et al., 2019).

To aid firms in gaining competitive edge within a dynamic marketplace in the course of digital transformation, a fast utilization of new technology (P4) facilitates firms to identify the present and future changes in CSCM. Cleaner technology (C21) supports less water contamination, fewer carbon emissions, ecological transport, environmentally friendly supply schemes, and sustainable production procedures (Moktadir et al., 2018). Technology infrastructure (C22) involves information and communication platforms, software, networking, hardware and intelligent devices. Technology competence (C23) reflects the knowledge, ability and skills needed to efficiently utilize technology infrastructure elements (Aboelmaged, 2018). The implementation of information technologies (C24) enables tracking product returns and sharing up-to-date information with partners in the supply chain (Bhatia et al., 2020). Information sharing (C25) facilitates collaboration with various partners, allowing enhanced information transparence and enabling CSCM business models' implementation (Tura et al., 2019).

Organizational capability (P5) represents a set of activities and actions that must be focused on to ensure the success of applying CSCM in firms. Firm culture (C26) is the pattern of fundamental assumptions that the firm develops to handle emerging obstacles and is disseminated throughout the company. Readiness for organizational change (C27) is the policy-making process of frequently reshaping and adapting firm structure, goals and strategy toward change. The presence of mutual trust and respect (C28) drives a firm to execute sustainable manufacturing practices (Ahuja et al., 2019). Sustainability concept integration (C29) in making decisions in all phases of remanufacturing substantially increases overall achievement. Lean tools (C30) are applied to promote process efficiency, product performance and optimal inventory levels (Ansari et al., 2019). As the adoption of CSCM calls for changes, a commitment of leadership and support from management (C31) enables smooth operations of CSCM (Bhatia et al., 2020). Employees' engagement (C32) motivates sustainable manufacturing, as employees influence decisions and support sustainability initiatives at varied firm levels (Aboelmaged, 2018).

(INSERT Table 1 here)

## 3. Methods

This section consists of industry background and FDM, FISM and the BWM proposed analytical procedures.

### 3.1. Industry background

In 2019, seafood exports reached approximately USD 8.6 billion (General Statistics Office of Vietnam, 2019). Vietnamese seafood products are exported to several countries and territories, including massive markets such as the European Union, Japan, the United States, South Korea and Russia. The seafood processing industry is one of the leading economic industries in Vietnam because it contributes to the national economy through economic growth, job creation, food security, and poverty alleviation (Tseng et al., 2020). The number of manufacturing and processing firms has rapidly increased, focusing on investment in modern technology and management and expanding processing capability. However, the accelerated growth of the Vietnamese seafood processing industry has led to shortcomings and environmental problems such as air and water pollution and resource waste. Specifically, the high usage of energy in seafood processing factories increases air pollution. Processing operations produces waste water in the form of blood water, polluted process water, stick water, and press liquor. Solid waste arises out of seafood processing operations comprising shell, flesh, cartilage, bones, and viscera. Additionally, waste from seafood product packaging is a matter of great concern. Accordingly, reorganizing the supply chain to be more circular is a growing need for the seafood processing industry.

Executing CSCM benefits seafood processing firms in Vietnam. In particular, the industry is able to minimize waste, utilize resources, save energy, reduce waste disposal and material costs, and improve its social image by implementing CSCM. Hence, this study is conducted to support the seafood processing industry in grasping the attributes that enable the industry's CSCM implementation, in turn achieving all benefits. In this study, experts were chosen based on purposive sampling. This kind of sampling pays primary attention on data saturation which means that new experts are continued to be engaged into the study until no new information is obtained. In particular, there were 14 experts involved with seven practitioners having a minimum of ten years of experience working in the seafood processing industry and seven experts who possessed more than 10 years of research experience in this field (Appendix 2 shows expert biographical information).

### 3.2. Fuzzy Delphi method

FDM is suggested by Ishikawa et al. (1993) for solving expert judgments' fuzziness, which has the advantage of reducing the number of interviews along with examination time while providing more complete experts' expression of ideas. The significance value attribute $x$ is assessed by expert $y$ as $j = \left(a_{xy}; b_{xy}; c_{xy}\right)$, $x = 1,2,3,\dots,n$; $y = 1,2,3,\dots,m$; next, weight $j_y$ of attribute $y$ is $j_y = \left(a_y; b_y; c_y\right)$, where $a_y = min\left(a_{xy}\right)$, $b_y = \left(\prod_1^n b_{xy}\right)^{1/n}$, $c_y = max\left(c_{xy}\right)$. FDM transforms linguistic terms into triangular fuzzy numbers (TFNs) (as seen from Table 2). Employing the a $\gamma$ cut to generate the convex combining value $E_x$.

$$p_x = c_x - \gamma(c_x - b_x),\ v_x = a_x - \gamma(b_x - a_x),\ x = 1,2,3,\dots,n \quad (1)$$

The $\gamma$ generally varies from 0 to 1 based on whether experts have positive or negative perceptions. This study uses 0.5 to denote $\gamma$ under common circumstances. Then, the precise $E_x$ value is computed as follows:

$$E_x = \int(p_x, v_x) = \varepsilon[p_x + (1-\varepsilon)v_x] \quad (2)$$

where $\varepsilon$ is adopted to address the decision makers' optimistic level and create judgments balanced among the expert group.

Finally, $\sigma = \sum_{x=1}^{n}(E_x/n)$ is calculated as the threshold to screen out the invalid.

- *If $E_x \geq \sigma$, attributer $x$ is accepted.*
- *If $E_x < \sigma$, attributer $x$ is eliminated.*

(INSERT Table 2 here)

### 3.3. Fuzzy interpretive structural modeling

It is presumed there are $t$ experts in committee who are requested to employ linguistic terms for evaluating influence/significance as $D_{ij}^t$ between criterion $C_i$ and criterion $C_j, i, j = 1,2, \cdots n$. The $D_{ij}^t$ can be presented as follows:

$$D_{ij}^{t} = \begin{bmatrix} & d_1^t & d_2^t & \cdots & d_j^t \\ d_1^t & d_{11}^t & d_{12}^t & \cdots & d_{1j}^t \\ d_2^t & d_{21}^t & d_{22}^t & \cdots & d_{2j}^t \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_i^t & d_{n1}^t & d_{n2}^t & \cdots & d_{nn}^t \end{bmatrix}$$

The offered evaluations denote qualitative information, which requires TFNs to convert into comparable values. Thus, $d_{ij}^{\tau}$ are also rewritten as $\left[x_{ij}^t, y_{ij}^t, z_{ij}^t\right]_{n\times n}$ (shown in Table 3).

(INSERT Table 3 here)

The procedures of defuzzification are described as follows.

(i). The TFNs are normalized as follows:

$$\bar{x}_{ij}^t = \left(x_{ij}^t - min\, x_{ij}^t\right)/\alpha$$
$$\bar{y}_{ij}^t = \left(y_{ij}^t - min\, y_{ij}^t\right)/\alpha \quad (3)$$
$$\bar{z}_{ij}^t = \left(z_{ij}^t - min\, z_{ij}^t\right)/\alpha$$

where $\alpha = max\, z_{ij}^{\tau} - min\, x_{ij}^{\tau}$.

(ii). The left $lv_{ij}^{\tau}$ and right $rv_{ij}^{\tau}$ normalized values are acquired:

$$lv_{ij}^t = \bar{y}_{ij}^t / \left(1 + \bar{y}_{ij}^t - \bar{x}_{ij}^t\right)$$
$$rv_{ij}^t = \bar{z}_{ij}^t / \left(1 + \bar{y}_{ij}^t - \bar{z}_{ij}^t\right) \quad (4)$$

(iii). The normalized crisp value $\theta_{ij}^t$ of each expert is generated:

$$\theta_{ij}^t = \left[lv_{ij}^t\left(1 - lv_{ij}^t\right) + \left(rv_{ij}^t\right)^2\right] / \left(1 + rv_{ij}^t - lv_{ij}^t\right) \quad (5)$$

(iv). The aggregating matrix from integrating all experts' crisp values is computed as follows:

$$A_{ij}^t = \sum_{i,j=1}^{n}\left(\theta_{ij}^t\right)/t = \left[a_{ij}\right]_{n\times n} \quad (6)$$

The probability of the relationship between $C_i$ and $C_j$ is considered in this study, and experts are asked to offer a possible number to confirm the probability as follows:

$$P_{ij}^{t} = \begin{bmatrix} & p_1^t & p_2^t & \cdots & p_j^t \\ p_1^t & p_{11}^t & p_{12}^t & \cdots & p_{1j}^t \\ p_2^t & p_{21}^t & p_{22}^t & \cdots & p_{2j}^t \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ p_i^t & p_{n1}^t & p_{n2}^t & \cdots & p_{nn}^t \end{bmatrix} = \left[p_{ij}\right]_{n\times n}, 0 \le p_{ij} \le 1.$$

Consequently, the expected matrix $X$ is calculated using Equation 7.

$$X = \left[a_{ij}\right]_{n\times n} \times \left[p_{ij}\right]_{n\times n} = \left[c_{ij}\right]_{n\times n} \quad (7)$$

The driving $\alpha$ and dependence $\beta$ power to employ the diagram are obtained as follows (Govindan et al., 2012):

$$\alpha = \left[\sum_{i=1}^{n} c_{ij}\right]_{n\times 1} = \left[c_i^{\alpha}\right]_{n\times 1}$$
$$\beta = \left[\sum_{j=1}^{n} c_{ij}\right]_{1\times n} = \left[c_j^{\beta}\right]_{1\times n} \quad (8)$$

Utilizing $\alpha$ and $\beta$ as horizontal and vertical axis maps the criteria.

The binary reachability and antecedent matrix are generated using the threshold $\alpha^t$ and $\beta^t$ values attained as follows:

$\alpha^t = \left[\sum_{i=1}^{n} c_{ij}\right]_{n\times 1}$, (9)

$if\ c_{ij} \geq \alpha^t, the\ reachability\ scale\ value\ is\ considered\ 1;\ otherwise, it\ is\ considered\ 0$

$\beta^t = \left[\sum_{i=1}^{n} c_{ij}\right]_{1\times n}$, (10)

$if\ c_{ij} \geq \beta^t, the\ antecedent\ scale\ value\ is\ considered\ 1;\ otherwise, it\ is\ considered\ 0$

Hence, the binary intersection set $S$ is acquired as follows:

$$\alpha^t = 1, R = \{C_1, C_2, \cdots C_n\}; \beta^t = 1, A = \{C_1, C_2, \cdots C_n\} \quad (11)$$

$$S = R \cap A \quad (12)$$

Finally, for each criterion, the frequency $G$ of the intersection set is calculated as follows:

$$G = \left[\sum_{j=1}^{n} s_{ij}\right]_{1\times n} = \left[s_j\right]_{1\times n} \quad (13)$$

The criterion with the lowest $G$ value needs to be selected as the first level, followed by the next levels.

### 3.4. Best-worst method

Various criteria weights are demonstrated in the BWM for group decision-making issues. Employing best-to-others and others-to-worst vectors for deciding weights of the criteria leads to persistent comparisons and enhances the result's accuracy (Rezaei, 2015; Rezaei, 2016). The FDM results were used to determine the worst (least significant) and best (most significant) criteria. Criteria weight is interpreted by Equation 14.

$$X_{Bn} = (x_{B1}, x_{B2}, x_{B3} \ldots \ldots x_{Bn}) \quad (14)$$

where $X_{Bn}$ expresses the best-to-others vector and $x_{Bn}$= $(a_{xy}; b_{xy}; c_{xy})$ shows the priority of attribute B compared to attribute n.

$$X_{mW} = (x_{1W}, x_{2W}, x_{3W} \ldots \ldots x_{mW})T \quad (15)$$

where $X_{mW}$ expresses the others-to-worst vector and $x_{mW}$= $(a_{xy}; b_{xy}; c_{xy})$ shows the priority of attribute $W^{th}$ over attribute m.

Once validating a linear paradigm of BWM, absolute maximum difference concerning entire groups of m criteria needed to be diminished, which is presented below.

$$\text{Absolute maximum difference} = (|\alpha_n - x_{Bn}|, |\beta_m - x_{mW}|) \quad (16)$$

where $(\alpha_n, \beta_m)$ is computed as $\alpha_n = (\frac{w_B}{w_n})$ and $\beta_m = (\frac{w_m}{w_W})$ and organized in a min-max paradigm. Linear paradigm is shown below (Rezaei, 2016).

$$\text{Paradigm} \begin{Bmatrix} \text{for} \min \varepsilon \\ |w_B - w_n x_{Bn}| \leq \varepsilon^L,\ |w_m - w_W x_{mW}| \leq \varepsilon^L \\ \sum_{n=0} w_n^* = 1,\ w_n^* \geq 0 \end{Bmatrix} \quad (17)$$

Thus, $(w_1^*, w_2^*, w_3^*, w_{4\ldots\ldots\ldots\ldots}^*, w_n^*)$ at the optimum weight value of $\varepsilon^{L*}$ are acquired; $\varepsilon^{L*}$ is $\in (0,1)$, signifying that a value approaches 0 stresses more consistently, and a value close to 1 indicates less consistency.

## 4. Results

This study proposed 55 criteria for identifying CSCM enablers. Respondents assessed the first set of CSCM depending on their knowledge of the seafood processing industry. Appendix Table 1 presents the screening results of the proposed criteria by adopting Eqs (1) - (2). Therefore, with the threshold value of 0.482, 32 criteria are accepted and rearranged into Table 4.

(INSERT Table 4 here)

Table 5 presents the sample assessment from expert 1, which is converted into TFN by referring to Table 3 by using Eq (3). For example, in the first row of block C1 in Table 4, expert 1 gave the assessment E, which is needed to shift this linguistic scale into TFN (0.3, 0.5, 0.7).

(INSERT Table 5 here)

Table 6 expresses the crisp value for criteria of expert 1 from the defuzzification procedure by employing Eqs. (4) - (5) with calculations dependent on the left and right normalized values.

(INSERT Table 6 here)

The expected matrix and the driving and dependence power are generated by adopting Eqs (6) - (8). Table 7 shows the integrated reachability matrix by using Eq (9). The integrated reachability scale is 1 if the value for a particular criterion in the expected matrix is greater than the threshold of driving power. Otherwise, the integrated reachability scale receives the value 0.

(INSERT Table 7 here)

The expected matrix provides input for forming a diagram characterizing driving and dependence power. Figure 2 is the influential diagram of criteria in which the horizontal axis depicts the driving power and the vertical axis depicts dependence power. Commitment of leadership and managerial support (C31), suppliers' collaboration (C17), firm culture (C26), readiness for organizational change (C27) and sustainability concept integration (C29) are important CSCM enablers.

(INSERT Figure 2 here)

Table 8 presents the antecedent matrix using Eq (10). The antecedent scale is 1 if the value for a particular criterion in the expected matrix is greater than the threshold of dependence power. Otherwise, the antecedent scale takes the value 0.

(INSERT Table 8 here)

The intersection was obtained for all criteria from the integrated reachability matrix together with the antecedent matrix. Table 9 summarizes the results of the intersection process applying Eqs (11) - (13).

(INSERT Table 9 here)

The 32 criteria are classified into 4 levels and organized into 5 major aspects describing areas that enable CSCM application, as shown in Figure 3. These aspects include organizational capability and agility (A5), technological advancement (A4) economic benefit (A3), environmental motivation (A2), corporate social responsibility and stakeholder pressures (A1).

(INSERT Figure 3 here)

In Figure 2, there are multiple criteria in level 4, level 3 and level 1; determining the relative significance of each criterion is essential to decision-making. Accordingly, Eq (17) is used to decide the weights of each criterion and the consistency of comparisons. Entire values of $\varepsilon^{L*}$ approach 0, which illustrates higher consistency. All criteria relative weights are calculated, and the ranking is designated. Thus, suppliers' collaboration and firm culture are decisive criteria for enhancing organizational capability and agility. The results also imply that cleaner technology and cost reduction are the keys to improving technological advancement and economic benefits. Firms promote corporate social responsibility and deal with stakeholders' pressures by efficiently using resources to cope with the challenge of resource scarcity and complying with government regulations.

## 5. Implications

The theoretical and managerial implications are shown in this section.

### 5.1. Theoretical implication

This study strengthens the literature by analyzing CSCM enablers under the umbrella of the TBL and dynamic capability view, hence attaining a better comprehension of circular supply chain study. The integration of the TBL and dynamic capability view facilitates the decision on adequate enablers that drive CSCM execution. Derivation from the five perspectives allowed this study to incorporate CSCM enablers. In the hierarchical structure, 32 criteria are organized into four levels and five aspects accordingly that present attributes for enabling CSCM adoption, embracing organizational capability and agility (A5), technological advancement (A4), economic benefit (A3), environmental motivation (A2), corporate social responsibility and stakeholder pressures (A1).

This study confirmed that organizational capability and agility (A5) are decisive enablers of CSCM. Organizational capability, especially top management support, employee engagement, collaboration with suppliers, and utilization of information technologies, positively affects CSCM execution. Top management is actively engaged in CSCM and encourages employee involvement by disseminating positive attitudes and providing routine training to enhance skills, incentivize, and clarify information flow schemes (Aboelmaged, 2018; Ansari et al., 2019; Jabbour et al., 2019; Ahuja et al., 2019). Strong and close collaboration with suppliers also drives a smooth operation toward CSCM (Moktadir et al., 2018). Furthermore, agility is needed to enhance the supply chain's ability to react more quickly to changing market and external uncertainties, thus promoting supply chain responsiveness toward sustainability in the supply chain (Geyi et al., 2020). Rapidly noticing changes and speedily recognizing opportunities in the environment, making definite decisions, integrating agility into the strategic vision and objectives of the supply chain, and adapting supply chain operations to the level are required to implement CSCM. Indeed, successful agility requires a proactive culture with readiness for organizational change and the employment of lean tools as a continuous improvement philosophy. Organizational capability and agility are a foundation of success in CSCM execution in the face of tough competition, unstable and dynamic market environments, and changeable customer demand.

The role of technological advancement (A4) and economic benefit (A3) is also highlighted as key enablers for CSCM in this study. Technological advancement supports CSCM application by supporting firms to increase supply chain visibility and flexibility, increase operational performance, utilize wastes during the manufacturing phase, improve process safety and resource efficiency, and implement smarter and more adjustable supply chain processes (De Jesus and Mendonça, 2018; Luthra and Mangla, 2018; Bag et al., 2021). Cutting-edge technologies could unlock the circularity of resources within supply chains, such as diminishing resource consumption, reducing excessive resource usage, reducing and recycling waste in production systems, tracking products postconsumption, enhancing productivity, and increasing efficiency and accuracy (de Sousa Jabbour et al., 2018; Rajput and Singh, 2019; Moktadir et al., 2020). Using cleaner technology and upgrading technology infrastructure and competence reduces pollution, contributing to decreased environmental deterioration. Furthermore, economic benefits stimulate firms to apply CSCM (De Jesus and Mendonça, 2018; Gusmerotti et al., 2019; Agyemang et al., 2019). Firms that pursue reducing costs, attaining revenue, enhancing market share, and creating value from waste and production side streams focus attention on executing CSCM, which in turn brings about improved image and reputation of firms (Bhanot et al., 2017; Govindan and Bouzon, 2018; Tura et al., 2019; Bhatia et al. 2020).

In addition to organizational capability and agility, technological advancement, and economic benefits, environmental motivation (A2) triggers firms to adopt CSCM in the context of more poisonous waste generation, natural resource scarcity, and a greater mindfulness of environmental needs (Moktadir et al., 2018; Bhatia et al., 2020). Adopting CSCM in firms is encouraged by willingness to reduce waste, extend the life cycle, decrease adverse environmental impacts, and efficiently take advantage of resources (Sharma et al., 2016; Nußholz, 2018; Singhal et al., 2020). Resource efficiency enabling less resource usage in products and processes includes reducing, reusing, and recycling, focusing on lowering material input in parallel with boosting resource utilization (Kristensen and Mosgaard, 2020). By separating useful materials and utilizing byproducts, better material use and cycles of valuable resources are attained in circular business (Tura et al., 2019).

Corporate social responsibility and stakeholder pressures (A1) are less emphasized than other aspects in driving CSCM and belong to the lowest level in the hierarchical structure. Corporate social responsibility entails a firm's policies depicting a firm's societal impacts on the environment within its scope of influence (Walker et al., 2021). Continuous pressure from stakeholders generates demand for firms to employ circular initiatives and alter the entire product life cycle, such as sourcing, producing, using, disposal and recovering product value after its end of life, as a measure to accomplish corporate social responsibility (Jakhar et al., 2018; Munny et al., 2019). Regulations and support from the government to stimulate cleaner production and end-of-life governance mandate that firms execute CSCM. While faced with vicious competition, firms are energized to execute CSCM, which improves their potential to gain competitive advantages (Agyemang et al., 2019). Customer pressure forces firms to implement CSCM as customers become more aware of environmental concerns and look for eco-friendly processes (Moktadir et al., 2018; Bhatia et al., 2020).

### 5.2. Managerial implication

This study indicates the top criteria regarding CSCM enablers in the seafood processing industry in Vietnam, including commitment of leadership and managerial support (C31), suppliers' collaboration (C17), firm culture (C26), readiness for organizational change (C27) and sustainability concept integration (C29). By improving these criteria, the other criteria are also enhanced. Figure 4 shows top criteria for practical implementation.

(INSERT Figure 4 here)

Commitment of leadership and managerial support (C31) act as key enablers for CSCM adoption in the seafood processing industry in Vietnam. Top managers must be fully aware of CSCM benefits and are the ones who first initiate such practices in firms. When managers are interested in CSCM, firms demonstrate a more active approach to its adoption. Without the dedication and commitment of top management in the first stage, all CSCM practices are certain to be either insufficiently utilized or eventually fail. Managerial support for mutual learning processes in firms and managers' communication of a clear CSCM strategy encourages employees to exhibit a greater dedication to its accomplishment. Managers should adopt a formal statement to note their commitment to CSCM, and the results firms wish to gain and proactive actions to fulfill those objectives. In addition, managers need to ensure resource allocation and build adequate capabilities to deploy CSCM initiatives in terms of circular product and packaging design, circular sourcing, circular production, management and technology. Managers need to empower long-term strategic thinking and create consensus on future directions for CSCM within firms.

In light of CSCM, collaboration guarantees circularity over the supply chain and promotes firm performance. Supply chain collaboration enables a firm and suppliers to cooperate in a complicated chain beyond the firm. Suppliers' collaboration (C17) is acute for CSCM implementation in the seafood processing industry. Firms are recommended to meet their suppliers frequently to enhance, communicate, and build a strong, trustful relationship, leading to more and high-quality information and knowledge sharing. Strategic partnership agreements with major suppliers are recommended to ensure stability and long-term cooperation. Firms should participate in joint programs with suppliers related to Vietnamese good aquaculture practices to ensure transparency, traceability, environmental protection and social responsibility in the supply chain. Firms must ensure that suppliers carry out detailed records for all features of production, food safety, feed, and disease management; fully committed to protecting the environment with the proper adoption of waste storage and disposal and preparation of environmental impact assessment reports; secure work conditions, health and safety, and labor rights in compliance with existing regulations. These measures enhance suppliers' engagement, decrease environmental impact and increase social welfare, resulting in CSCM and confirming that supply chain members move forward together.

Firm culture (C26) regards the norms, beliefs and basic values shared within a firm involving relevant business disciplines in the supply chain. Seafood processing firms need to build and maintain a unique culture to utilize human resources, increase each individual's value, and contribute to the firm's development. To execute CSCM, commitments from leadership must be supported by a firm culture that interprets them into definite plans and actions. In the development process, managers try to build a value system that creates consensus within the firm and a positive atmosphere to encourage collective strengths and augment the firm's internal advantages. Managers must be examples to employees in firms. Shared norms and values enable employees to adopt attitudes and behaviors that are consistent with firms' culture. Information dissemination and extensive training courses should be carried out to cultivate and raise the awareness of employees about the significance and benefits of applying CSCM. Firms need to build trust in employees and give some rewards for those with better ideas of improvement and creativity in the CSCM execution.

Due to the changing nature of the market environment, some circumstances are beyond firms' boundaries, which serve as an opportunity for firms to recognize and manage changes. Such changes increase operational efficiency and competitiveness by securing brand image and establishing trust in customers. Readiness for organizational change (C27) toward CSCM aids seafood processing firms in adjusting activities in supply chains to acknowledge the TBL impacts of their operations. Change management requires cautious planning, executing detailed action plans, and including everyone who is influenced by these changes. Managers should create a sense of urgency for change in firms, particularly the need to facilitate changes by explaining, communicating, assigning the necessary tasks to actualize the changes with the awareness that employees are central for change and assuring their full engagement in such a process. Attitudes, skills, motivations, and knowledge of employees form noteworthy elements of the firm's environment in which change is pursued.

Seafood processing firms face intense pressures such as achieving economic benefits and simultaneously fulfilling social and environmental responsibility as a consequence of intense globalization and international integration. Hence, the sustainability concept (C29) must be embedded in seafood processing firms' strategy, operations, and supply chain and pinpointed as a strategic direction to decrease adverse impacts from firms' activities. To move toward CSCM and sustainability, firms need to look at everything from a holistic viewpoint to comprehend the interrelationship among economic growth and environmental and social sustainability. Firms must replace the money-focused values in the firm culture with more comprehensive thinking, which focuses on environmental management and social welfare. As a result, integrating sustainability concepts across the entire supply chain facilitates firms to achieve economic benefits, diminish environmental effects and social consequences, and sustain a competitive position in the market. Applying sustainability as a strategic means for the whole firm creates a solid basis for moving in the direction of CSCM.

## 6. Conclusions

With the aim of optimizing resource utilization together with minimizing waste, CSCM execution is a demanding requirement for the seafood processing industry. Even though circular supply chains have gained much concern, prior studies are negligent in building a hierarchical structure of CSCM enablers. This study is executed to investigate a valid set of CSCM enablers and construct a hierarchical structure for providing direction to support decision making. Stemming from the TBL, dynamic capability view, and experts' evaluation, a set of 32 criteria are determined and classified into five aspects. A hybrid method was employed to investigate CSCM enablers in the seafood processing industry in Vietnam. The fuzzy linguistic experts' experiences were transformed into crisp values, which were then used for the assessment procedure to reduce CSCM ambiguity and complications. Utilizing the FDM to eliminate incorrect attributes, FISM was executed to build a hierarchical structure of CSCM enablers. In a hierarchical structure, the criteria weight was determined by exploiting the BWM.

The findings show the top criteria in the seafood processing industry in Vietnam, including commitment of leadership and managerial support, suppliers' collaboration, firm culture, readiness for organizational change and sustainability concept integration. These criteria illustrate the most fundamental criteria that enable decision-makers in seafood processing firms to strengthen overall performance. This study is applied in the seafood processing industry to strengthen the causal attributes and drive CSCM implementation. In particular, top management initiatives of CSCM secure resource allocation along with building sufficient capabilities for its application. Furthermore, CSCM is driven by strong and strategic collaboration with suppliers. In addition, managers must create a firm culture with the readiness for change and integrate the sustainability concept into the firms' strategy and across the supply chain to facilitate CSCM.

This study's contributions are both theoretical and practical, including investigating hierarchical structure in addition to showing pivotal attributes for enabling CSCM. Specifically, organizational capability and agility, technological advancement, economic benefit, environmental motivation, corporate social responsibility and stakeholder pressures are indispensable to drive CSCM. The results lend support to the most important role of organizational capability and agility in facilitating CSCM, as organizational capability and agility leverage the other aspects in achieving circularity in supply chain management. Organizational capability and agility facilitate technological advancement, economic benefit, environmental motivation, corporate social responsibility and stakeholders' pressures to enable CSCM. Hence, focusing first on organizational capability and agility allows decision-makers to systematically apply better measures to realize the benefits gained by implementing CSCM.

However, this study has some limitations that offer opportunities for prospective study directions. Proposed attributes were chosen from prior studies and experts' opinions, both of which might inhibit the framework's comprehensiveness. Additional attributes should be included in future studies to enhance the present work. There are some disadvantages relating to the adoption of FISM. The context of analysis regularly depends upon experts' specific understanding, experience, and comprehension of the industry, which could have induced bias in conclusions to some extent. Hence, other alternative techniques are recommended in future studies to solve this problem. Directing attention to the seafood processing industry in Vietnam places constraints on the generalizability of the results. Future study is encouraged to use a similar approach in various industries and countries or regions, providing more multidimensional interpretation.

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**Tables**

Table 1. Proposed measures

| Perspective | Criteria | | Description | References |
|---|---|---|---|---|
| Environmental management (P1) | C1 | Minimize waste generation | Adopting circular supply chain management results in waste generation reduction | Bhatia et al., 2020<br>Tura et al., 2019<br>Govindan and Hasanagic, 2018<br>Sharma et al., 2016 |
| | C2 | Resource conservation | Remanufacturing contributes substantially to the resource conservation | |
| | C3 | Save energy | Remanufacturing contributes substantially to save energy | |
| | C4 | Resource scarcity | Resource scarcity is influential driver to sustainable manufacturing practices of a circular economy | |
| | C5 | Possibilities to prevent negative environmental impacts | The origin reason for advancing the readiness to adopt circular economy arises from the demand to decrease adverse environmental impacts | |
| | C6 | Climate change | Climate change occurs due to the waste amount generated and the greenhouse gas emissions accompanied by the consumption used | |
| Economic benefit (P2) | C7 | Cost reduction | The capability of reducing products' costs drives firms to deal with circular supply chain | Bhatia et al., 2020<br>Agyemang et al., 2019<br>Tura et al., 2019<br>Govindan and Hasanagic, 2018<br>Vlajic et al., 2018<br>Moktadir et al., 2018 |
| | C8 | Revenue gains | Implementing circular supply chain advances the long-term revenue generation by efficient recycling and remanufacturing activities | |
| | C9 | Competitive advantage | Sustainable manufacturing practices assure competitive advantages for firms in the market | |
| | C10 | Sustainable business and growth | Adopting circular supply chain as a way to position firms to react to the market, strengthens sustainable business and growth | |
| | C11 | Value recovery | Potential of value recovery brings opportunity for adoption of circular supply chain | |
| | C12 | Integration of manufacturing and remanufacturing operations | Firms with restricted resources integrate remanufacturing and manufacturing operations to use the existing resources efficiently | |
| Social responsibility (P3) | C13 | Healthy and safe working conditions | Firms supplying healthy and safe working conditions and accomplishing social welfare responsibility find enhanced support from each employee to fulfil the objective | Bhatia et al., 2020<br>Agyemang et al., 2019<br>Ansari et al., 2019<br>Munny et al., 2019<br>Govindan and Bouzon, 2018<br>Moktadir et al., 2018 |
| | C14 | Wages and benefit | Wages and benefit relate to proper payment and related sustainable employment issues | |

| | | | | |
|---|---|---|---|---|
| | C15 | Brand protection | Brand protection is one of enablers of reverse logistics as a result of the competition and the significant brand erosion insists on the decision to perform reverse logistics | Sharma et al., 2016 |
| | C16 | Improve green image and reputation | Firms execute remanufacturing practices to reinforce green image and reputation | |
| | C17 | Suppliers' collaboration | Suppliers' collaboration is important driver for a smooth operation to circular economy | |
| | C18 | Government regulation and support | Government regulations and support are essential for the adopting of circular supply chain practices in firms. | |
| | C19 | Customers' awareness | Customers' awareness of environmental protection creates pressure on firms to apply CSCM practices | |
| | C20 | International competition | Facing intense and radical competition in the environment, firms are motivated to perform CSCM which increase their potential to achieve competitive advantage | |
| Technological development (P4) | C21 | Cleaner technology | Cleaner technology (C21) secures lower water contamination, fewer carbon emissions, ecological transport, environment-friendly supply scheme, sustainable production procedures | Bhatia et al., 2020<br>Tura et al., 2019<br>Moktadir et al., 2018<br>Aboelmaged, 2018 |
| | C22 | Technology infrastructure | Technology infrastructure involves platforms of information and communication, hardware, software, networking, intelligent devices | |
| | C23 | Technology competence | Technology competence reflects knowledge, ability and skills needed to efficiently utilize technology infrastructure elements | |
| | C24 | Implementation of information technologies | Implementation of information technologies enables tracking product returns, sharing up-to-date information with partners in supply chain | |
| | C25 | Information sharing | Information sharing favor favors collaboration with various partners, allowing enhanced information transparence, enabling CSCM business models' employment | |
| Organizational capability (P5) | C26 | Firm culture | Firm culture is the pattern of fundamental assumptions that firm develops to handle emerging | Bhatia et al., 2020<br>Ahuja et al., 2019<br>Ansari et al., 2019 |

| | | | |
|---|---|---|---|
| | | obstacles and is disseminated across employees' generations | Aboelmaged, 2018 |
| C27 | Readiness for organizational change | Change management is the policy-making process of frequently reshaping and adapting firm structure, goals and strategy towards change | |
| C28 | Mutual trust and respect | The presence of mutual trust and respect drives a firm in executing sustainable manufacturing practices | |
| C29 | Sustainability concept integration | Sustainability concept integration in making decisions in all phases of remanufacturing substantially increases overall achievement | |
| C30 | Lean tools | Lean tools are applied to promote product performance, process efficiency and optimal inventory levels | |
| C31 | Commitment of leadership and managerial support | As the adoption of CSCM calls for changes, a commitment of leadership and support from management enables smooth operations of CSCM | |
| C32 | Employees' engagement | Employees' engagement motivates sustainable manufacturing as they influence decisions and support sustainable efforts at varied firm levels | |

Table 2. Transformation table of linguistic terms

| Linguistic terms (performance/importance) | Corresponding triangular fuzzy numbers |
|---|---|
| Extreme | (0.75, 1.0, 1.0) |
| Demonstrated | (0.5, 0.75, 1.0) |
| Strong | (0.25, 0.5, 0.75) |
| Moderate | (0, 0.25, 0.5) |
| Equal | (0, 0, 0.25) |

Table 3. Contrasting TFN for linguistic preferences

| Linguistic terms | Meanings | Corresponding TFN |
|---|---|---|
| $NI$ | No influence/importance | (0.0, 0.1, 0.3) |
| $VL$ | Very low influence/importance | (0.1, 0.3, 0.5) |
| $E$ | Equal influence/importance | (0.3, 0.5, 0.7) |
| $HI$ | High influence/importance | (0.5, 0.7, 0.9) |
| $VH$ | Very high influence/importance | (0.7, 0.9, 1.0) |

Table 4. FDM result

| Criteria | $p_x$ | $v_x$ | $E_x$ | Decision |
|---|---|---|---|---|
| C1 | (0.306) | 0.806 | 0.537 | Accepted |
| C2 | (0.306) | 0.806 | 0.537 | Accepted |
| C3 | 0.046 | 0.828 | 0.635 | Accepted |
| C4 | (0.285) | 0.785 | 0.523 | Accepted |
| C5 | (0.302) | 0.802 | 0.535 | Accepted |
| C6 | (0.263) | 0.763 | 0.508 | Accepted |
| C7 | 0.023 | 0.851 | 0.651 | Accepted |
| C8 | (0.008) | 0.883 | 0.672 | Accepted |
| C9 | 0.013 | 0.861 | 0.657 | Accepted |
| C10 | (0.017) | 0.892 | 0.678 | Accepted |
| C11 | 0.046 | 0.828 | 0.635 | Accepted |
| C12 | 0.037 | 0.837 | 0.641 | Accepted |
| C13 | 0.002 | 0.872 | 0.665 | Accepted |
| C14 | 0.050 | 0.824 | 0.632 | Accepted |
| C15 | (0.306) | 0.806 | 0.537 | Accepted |
| C16 | 0.046 | 0.828 | 0.635 | Accepted |
| C17 | 0.037 | 0.837 | 0.641 | Accepted |
| C18 | 0.375 | 0.875 | 0.750 | Accepted |
| C19 | (0.337) | 0.837 | 0.558 | Accepted |
| C20 | 0.084 | 0.790 | 0.610 | Accepted |
| C21 | (0.328) | 0.828 | 0.552 | Accepted |
| C22 | (0.294) | 0.794 | 0.529 | Accepted |
| C23 | (0.318) | 0.818 | 0.545 | Accepted |
| C24 | (0.302) | 0.802 | 0.535 | Accepted |
| C25 | (0.318) | 0.818 | 0.545 | Accepted |
| C26 | (0.274) | 0.774 | 0.516 | Accepted |
| C27 | (0.315) | 0.815 | 0.543 | Accepted |
| C28 | (0.347) | 0.847 | 0.565 | Accepted |
| C29 | (0.337) | 0.837 | 0.558 | Accepted |
| C30 | (0.306) | 0.806 | 0.537 | Accepted |
| C31 | 0.059 | 0.815 | 0.626 | Accepted |
| C32 | (0.333) | 0.833 | 0.555 | Accepted |
| Threshold | | | 0.482 | |

# Table 5. Fuzzy assessment from expert 1

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 |
|---|---|---|---|---|---|---|---|---|
| C1 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C2 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C3 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C4 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C5 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C6 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C7 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.0 0.1 0.3) |
| C8 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C9 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C10 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C11 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) |
| C12 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) |
| C13 | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C14 | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C15 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) |
| C16 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) |
| C17 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C18 | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C19 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C20 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C21 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C22 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C23 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C24 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C25 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C26 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C27 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C28 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C29 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C30 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C31 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C32 | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |

| | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 |
|---|---|---|---|---|---|---|---|---|
| C1 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C2 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C3 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C4 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C5 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C6 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) |
| C7 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C8 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C9 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C10 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C11 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C12 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C13 | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C14 | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C15 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) |
| C16 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C17 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C18 | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C19 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C20 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C21 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C22 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C23 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C24 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C25 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C26 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C27 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C28 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C29 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C30 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C31 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C32 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |

| | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 |
|---|---|---|---|---|---|---|---|---|
| C1 | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.7 0.9 1.0) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C2 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C3 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C4 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C5 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C6 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C7 | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C8 | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C9 | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C10 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C11 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C12 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C13 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C14 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C15 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C16 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C17 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C18 | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C19 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C20 | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C21 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C22 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C23 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C24 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C25 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C26 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C27 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C28 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C29 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C30 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C31 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C32 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |

| | C25 | C26 | C27 | C28 | C29 | C30 | C31 | C32 |
|---|---|---|---|---|---|---|---|---|
| C1 | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.7 0.9 1.0) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C2 | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C3 | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C4 | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C5 | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.1 0.3 0.5) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C6 | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C7 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C8 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C9 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C10 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.3 0.5 0.7) |
| C11 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) |
| C12 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C13 | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C14 | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C15 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C16 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.5 0.7 0.9) |
| C17 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C18 | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) | (0.0 0.1 0.3) |
| C19 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C20 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.0 0.1 0.3) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C21 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C22 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C23 | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C24 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C25 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.1 0.3 0.5) |
| C26 | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C27 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) |
| C28 | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C29 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |
| C30 | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.1 0.3 0.5) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.3 0.5 0.7) |
| C31 | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.7 0.9 1.0) | (0.5 0.7 0.9) | (0.7 0.9 1.0) | (0.3 0.5 0.7) | (0.3 0.5 0.7) | (0.1 0.3 0.5) |
| C32 | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.5 0.7 0.9) | (0.3 0.5 0.7) | (0.7 0.9 1.0) | (0.3 0.5 0.7) | (0.5 0.7 0.9) | (0.3 0.5 0.7) |

Table 6. Crisp value from expert 1

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 | C29 | C30 | C31 | C32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 0.42 | 0.20 | 0.20 | 0.26 | 0.64 | 0.26 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.64 | 0.64 | 0.58 | 0.64 | 0.76 | 0.76 | 0.76 | 0.64 | 0.20 | 0.76 | 0.58 | 0.20 | 0.76 | 0.84 | 0.76 | 0.64 |
| C2 | 0.42 | 0.42 | 0.42 | 0.54 | 0.64 | 0.26 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.64 | 0.44 | 0.58 | 0.64 | 0.58 | 0.58 | 0.58 | 0.64 | 0.20 | 0.58 | 0.58 | 0.20 | 0.76 | 0.61 | 0.76 | 0.64 |
| C3 | 0.42 | 0.20 | 0.42 | 0.54 | 0.64 | 0.26 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.64 | 0.44 | 0.58 | 0.64 | 0.58 | 0.58 | 0.58 | 0.64 | 0.20 | 0.38 | 0.58 | 0.20 | 0.76 | 0.61 | 0.58 | 0.64 |
| C4 | 0.20 | 0.20 | 0.42 | 0.54 | 0.42 | 0.26 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.42 | 0.22 | 0.38 | 0.42 | 0.58 | 0.58 | 0.58 | 0.64 | 0.20 | 0.38 | 0.38 | 0.20 | 0.76 | 0.61 | 0.38 | 0.42 |
| C5 | 0.42 | 0.42 | 0.42 | 0.54 | 0.42 | 0.26 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.64 | 0.44 | 0.58 | 0.64 | 0.58 | 0.58 | 0.58 | 0.64 | 0.20 | 0.38 | 0.76 | 0.20 | 0.76 | 0.61 | 0.76 | 0.64 |
| C6 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.54 | 0.00 | 0.00 | 0.00 | 0.42 | 0.42 | 0.42 | 0.00 | 0.00 | 0.20 | 0.42 | 0.42 | 0.22 | 0.38 | 0.42 | 0.38 | 0.38 | 0.38 | 0.20 | 0.20 | 0.19 | 0.58 | 0.20 | 0.38 | 0.40 | 0.38 | 0.42 |
| C7 | 0.64 | 0.64 | 0.64 | 0.26 | 0.42 | 0.26 | 0.42 | 0.00 | 0.54 | 0.42 | 0.64 | 0.64 | 0.26 | 0.26 | 0.42 | 0.42 | 0.64 | 0.00 | 0.19 | 0.42 | 0.38 | 0.58 | 0.58 | 0.64 | 0.42 | 0.38 | 0.38 | 0.20 | 0.38 | 0.61 | 0.58 | 0.42 |
| C8 | 0.42 | 0.42 | 0.64 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.64 | 0.64 | 0.26 | 0.26 | 0.42 | 0.42 | 0.64 | 0.00 | 0.19 | 0.42 | 0.38 | 0.58 | 0.58 | 0.64 | 0.42 | 0.38 | 0.58 | 0.20 | 0.38 | 0.40 | 0.58 | 0.42 |
| C9 | 0.64 | 0.64 | 0.64 | 0.26 | 0.42 | 0.26 | 0.64 | 0.64 | 0.54 | 0.64 | 0.64 | 0.64 | 0.26 | 0.26 | 0.64 | 0.64 | 0.64 | 0.00 | 0.38 | 0.42 | 0.58 | 0.58 | 0.58 | 0.64 | 0.64 | 0.38 | 0.58 | 0.42 | 0.58 | 0.40 | 0.58 | 0.42 |
| C10 | 0.64 | 0.64 | 0.64 | 0.26 | 0.64 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.64 | 0.64 | 0.26 | 0.26 | 0.64 | 0.64 | 0.64 | 0.44 | 0.58 | 0.64 | 0.76 | 0.58 | 0.58 | 0.64 | 0.64 | 0.58 | 0.58 | 0.64 | 0.76 | 0.61 | 0.76 | 0.42 |
| C11 | 0.42 | 0.42 | 0.42 | 0.26 | 0.42 | 0.26 | 0.20 | 0.20 | 0.54 | 0.42 | 0.42 | 0.64 | 0.26 | 0.26 | 0.42 | 0.20 | 0.64 | 0.22 | 0.38 | 0.42 | 0.38 | 0.38 | 0.58 | 0.20 | 0.64 | 0.38 | 0.38 | 0.42 | 0.58 | 0.20 | 0.38 | 0.42 |
| C12 | 0.20 | 0.20 | 0.42 | 0.26 | 0.42 | 0.26 | 0.20 | 0.20 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.20 | 0.64 | 0.22 | 0.38 | 0.42 | 0.38 | 0.58 | 0.58 | 0.64 | 0.64 | 0.38 | 0.38 | 0.42 | 0.58 | 0.20 | 0.58 | 0.42 |
| C13 | 0.00 | 0.00 | 0.00 | 0.26 | 0.20 | 0.26 | 0.20 | 0.42 | 0.26 | 0.42 | 0.20 | 0.42 | 0.54 | 0.26 | 0.42 | 0.42 | 0.42 | 0.44 | 0.38 | 0.20 | 0.58 | 0.19 | 0.38 | 0.20 | 0.20 | 0.58 | 0.19 | 0.64 | 0.58 | 0.20 | 0.58 | 0.42 |
| C14 | 0.00 | 0.00 | 0.00 | 0.26 | 0.20 | 0.26 | 0.20 | 0.42 | 0.26 | 0.42 | 0.20 | 0.42 | 0.26 | 0.54 | 0.42 | 0.42 | 0.42 | 0.44 | 0.38 | 0.20 | 0.38 | 0.19 | 0.38 | 0.20 | 0.20 | 0.58 | 0.38 | 0.64 | 0.38 | 0.00 | 0.58 | 0.42 |
| C15 | 0.42 | 0.42 | 0.42 | 0.26 | 0.42 | 0.26 | 0.42 | 0.64 | 0.54 | 0.42 | 0.64 | 0.42 | 0.26 | 0.26 | 0.42 | 0.64 | 0.64 | 0.44 | 0.38 | 0.20 | 0.58 | 0.38 | 0.58 | 0.42 | 0.42 | 0.58 | 0.58 | 0.42 | 0.58 | 0.40 | 0.76 | 0.64 |
| C16 | 0.64 | 0.64 | 0.42 | 0.26 | 0.42 | 0.26 | 0.42 | 0.64 | 0.54 | 0.42 | 0.64 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.64 | 0.22 | 0.38 | 0.20 | 0.58 | 0.38 | 0.58 | 0.42 | 0.42 | 0.58 | 0.58 | 0.64 | 0.76 | 0.40 | 0.76 | 0.64 |
| C17 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.58 | 0.42 | 0.38 | 0.38 | 0.38 | 0.64 | 0.64 | 0.58 | 0.58 | 0.00 | 0.58 | 0.40 | 0.58 | 0.20 |
| C18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C19 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.00 | 0.38 | 0.20 | 0.38 | 0.38 | 0.38 | 0.42 | 0.42 | 0.38 | 0.38 | 0.00 | 0.38 | 0.40 | 0.38 | 0.20 |
| C20 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.20 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.00 | 0.58 | 0.42 | 0.38 | 0.19 | 0.38 | 0.42 | 0.42 | 0.38 | 0.38 | 0.00 | 0.19 | 0.40 | 0.38 | 0.20 |
| C21 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.58 | 0.42 | 0.38 | 0.58 | 0.38 | 0.42 | 0.42 | 0.38 | 0.38 | 0.20 | 0.58 | 0.40 | 0.58 | 0.20 |
| C22 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.19 | 0.42 | 0.58 | 0.38 | 0.58 | 0.42 | 0.42 | 0.38 | 0.58 | 0.20 | 0.58 | 0.40 | 0.58 | 0.20 |
| C23 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.19 | 0.42 | 0.58 | 0.58 | 0.38 | 0.64 | 0.64 | 0.58 | 0.58 | 0.20 | 0.58 | 0.40 | 0.58 | 0.42 |
| C24 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.19 | 0.42 | 0.38 | 0.58 | 0.58 | 0.42 | 0.64 | 0.58 | 0.58 | 0.20 | 0.38 | 0.40 | 0.58 | 0.20 |
| C25 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.64 | 0.22 | 0.19 | 0.42 | 0.38 | 0.58 | 0.38 | 0.42 | 0.42 | 0.58 | 0.58 | 0.20 | 0.38 | 0.20 | 0.58 | 0.20 |
| C26 | 0.42 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.38 | 0.42 | 0.38 | 0.38 | 0.38 | 0.42 | 0.42 | 0.38 | 0.38 | 0.42 | 0.58 | 0.40 | 0.58 | 0.42 |
| C27 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.54 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.76 | 0.42 | 0.38 | 0.58 | 0.38 | 0.42 | 0.64 | 0.58 | 0.38 | 0.20 | 0.58 | 0.40 | 0.58 | 0.64 |
| C28 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.38 | 0.20 | 0.38 | 0.38 | 0.38 | 0.42 | 0.20 | 0.58 | 0.38 | 0.42 | 0.38 | 0.20 | 0.58 | 0.42 |
| C29 | 0.42 | 0.20 | 0.20 | 0.54 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.44 | 0.38 | 0.20 | 0.58 | 0.38 | 0.38 | 0.42 | 0.42 | 0.58 | 0.58 | 0.20 | 0.38 | 0.40 | 0.58 | 0.42 |
| C30 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.22 | 0.58 | 0.20 | 0.58 | 0.38 | 0.38 | 0.42 | 0.42 | 0.58 | 0.58 | 0.20 | 0.58 | 0.40 | 0.76 | 0.42 |
| C31 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.44 | 0.00 | 0.42 | 0.58 | 0.38 | 0.58 | 0.64 | 0.64 | 0.76 | 0.76 | 0.64 | 0.76 | 0.40 | 0.38 | 0.20 |
| C32 | 0.20 | 0.20 | 0.20 | 0.26 | 0.42 | 0.26 | 0.42 | 0.42 | 0.54 | 0.42 | 0.42 | 0.42 | 0.26 | 0.26 | 0.42 | 0.42 | 0.42 | 0.44 | 0.58 | 0.42 | 0.38 | 0.38 | 0.38 | 0.42 | 0.42 | 0.58 | 0.58 | 0.42 | 0.76 | 0.40 | 0.58 | 0.42 |

Table 7. Integrated reachability matrix

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 | C29 | C30 | C31 | C32 | β |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 6.786 | 5.977 | 6.552 | 5.556 | 6.654 | 5.180 | 6.285 | 6.525 | 7.030 | 8.002 | 7.316 | 7.509 | 5.315 | 5.273 | 7.188 | 7.254 | 8.525 | 7.880 | 6.679 | 6.902 | 8.041 | 8.063 | 8.058 | 7.370 | 7.003 | 8.489 | 8.243 | 5.990 | 8.240 | 7.359 | 9.098 | 7.173 | 7.110 |
| C2 | 6.276 | 5.515 | 6.029 | 5.165 | 6.133 | 4.772 | 5.659 | 5.878 | 6.305 | 7.306 | 6.688 | 6.879 | 4.769 | 4.699 | 6.525 | 6.599 | 7.851 | 7.219 | 6.104 | 6.307 | 7.347 | 7.364 | 7.396 | 6.771 | 6.331 | 7.761 | 7.490 | 5.428 | 7.587 | 6.782 | 8.339 | 6.574 | 6.495 |
| C3 | 6.057 | 5.323 | 5.913 | 4.987 | 5.952 | 4.630 | 5.708 | 5.883 | 6.315 | 7.207 | 6.584 | 6.769 | 4.820 | 4.760 | 6.487 | 6.553 | 7.719 | 7.042 | 6.023 | 6.242 | 7.199 | 7.229 | 7.248 | 6.667 | 6.342 | 7.697 | 7.458 | 5.458 | 7.481 | 6.675 | 8.252 | 6.536 | 6.413 |
| C4 | 4.212 | 3.820 | 4.149 | 3.615 | 4.187 | 3.360 | 3.845 | 3.998 | 4.245 | 4.986 | 4.579 | 4.709 | 3.193 | 3.153 | 4.378 | 4.429 | 5.331 | 4.844 | 4.108 | 4.299 | 5.003 | 5.040 | 5.068 | 4.622 | 4.264 | 5.164 | 5.085 | 3.602 | 5.154 | 4.611 | 5.637 | 4.427 | 4.410 |
| C5 | 5.713 | 5.067 | 5.528 | 4.669 | 5.585 | 4.361 | 5.176 | 5.370 | 5.783 | 6.704 | 6.140 | 6.318 | 4.395 | 4.297 | 5.990 | 6.071 | 7.223 | 6.586 | 5.590 | 5.811 | 6.756 | 6.752 | 6.762 | 6.173 | 5.802 | 7.137 | 6.882 | 4.992 | 6.981 | 6.218 | 7.665 | 6.069 | 5.955 |
| C6 | 3.718 | 3.356 | 3.615 | 3.118 | 3.709 | 3.003 | 3.220 | 3.344 | 3.570 | 4.285 | 3.945 | 4.091 | 2.730 | 2.655 | 3.732 | 3.820 | 4.632 | 4.318 | 3.562 | 3.692 | 4.347 | 4.354 | 4.389 | 3.907 | 3.599 | 4.504 | 4.361 | 3.153 | 4.474 | 4.005 | 4.932 | 3.890 | 3.813 |
| C7 | 6.366 | 5.528 | 6.308 | 4.860 | 5.964 | 4.498 | 6.131 | 6.280 | 6.679 | 7.571 | 6.952 | 7.131 | 4.988 | 5.010 | 6.784 | 6.819 | 8.214 | 7.166 | 6.093 | 6.377 | 7.395 | 7.570 | 7.584 | 7.049 | 6.611 | 8.012 | 7.790 | 5.624 | 7.710 | 7.085 | 8.655 | 6.796 | 6.675 |
| C8 | 6.425 | 5.569 | 6.327 | 4.855 | 6.043 | 4.521 | 6.230 | 6.412 | 6.806 | 7.670 | 7.064 | 7.222 | 5.150 | 5.153 | 6.929 | 6.960 | 8.343 | 7.254 | 6.176 | 6.472 | 7.502 | 7.661 | 7.679 | 7.137 | 6.739 | 8.167 | 7.962 | 5.844 | 7.804 | 7.118 | 8.797 | 6.938 | 6.779 |
| C9 | 7.186 | 6.204 | 7.068 | 5.376 | 6.677 | 4.968 | 6.940 | 7.187 | 7.530 | 8.526 | 7.825 | 8.006 | 5.703 | 5.694 | 7.712 | 7.747 | 9.261 | 8.030 | 6.868 | 7.112 | 8.347 | 8.527 | 8.540 | 7.938 | 7.496 | 9.050 | 8.833 | 6.484 | 8.673 | 7.873 | 9.770 | 7.685 | 7.526 |
| C10 | 7.525 | 6.544 | 7.347 | 5.753 | 7.104 | 5.359 | 7.131 | 7.333 | 7.790 | 8.826 | 8.135 | 8.321 | 5.916 | 5.891 | 7.997 | 8.051 | 9.589 | 8.505 | 7.217 | 7.466 | 8.779 | 8.883 | 8.888 | 8.212 | 7.713 | 9.462 | 9.139 | 6.733 | 9.083 | 8.183 | 10.194 | 8.025 | 7.847 |
| C11 | 5.219 | 4.544 | 5.109 | 4.065 | 4.966 | 3.776 | 4.977 | 5.124 | 5.468 | 6.263 | 5.731 | 5.938 | 4.223 | 4.229 | 5.645 | 5.659 | 6.757 | 5.990 | 5.099 | 5.253 | 6.130 | 6.235 | 6.251 | 5.700 | 5.455 | 6.664 | 6.420 | 4.792 | 6.431 | 5.745 | 7.180 | 5.652 | 5.522 |
| C12 | 5.130 | 4.474 | 5.060 | 3.992 | 4.897 | 3.693 | 4.965 | 5.126 | 5.453 | 6.171 | 5.680 | 5.798 | 4.163 | 4.187 | 5.597 | 5.598 | 6.662 | 5.874 | 4.999 | 5.205 | 6.048 | 6.175 | 6.175 | 5.669 | 5.429 | 6.564 | 6.345 | 4.721 | 6.307 | 5.686 | 7.076 | 5.588 | 5.453 |
| C13 | 4.819 | 4.221 | 4.730 | 3.718 | 4.571 | 3.557 | 5.061 | 5.340 | 5.672 | 6.083 | 5.433 | 5.545 | 4.556 | 4.563 | 5.721 | 5.730 | 6.404 | 6.023 | 5.046 | 5.067 | 5.928 | 5.943 | 5.895 | 5.583 | 5.602 | 6.705 | 6.480 | 5.182 | 6.109 | 5.425 | 7.116 | 5.639 | 5.421 |
| C14 | 4.973 | 4.299 | 4.956 | 3.782 | 4.611 | 3.546 | 5.360 | 5.601 | 5.875 | 6.274 | 5.690 | 5.755 | 4.639 | 4.717 | 5.887 | 5.886 | 6.659 | 6.041 | 5.144 | 5.222 | 6.013 | 6.113 | 6.105 | 5.791 | 5.807 | 6.932 | 6.735 | 5.317 | 6.300 | 5.718 | 7.364 | 5.814 | 5.591 |
| C15 | 7.437 | 6.517 | 7.245 | 5.763 | 7.082 | 5.387 | 7.202 | 7.535 | 7.998 | 8.925 | 8.176 | 8.296 | 6.214 | 6.171 | 8.115 | 8.230 | 9.596 | 8.615 | 7.367 | 7.499 | 8.862 | 8.887 | 8.898 | 8.242 | 7.882 | 9.680 | 9.349 | 7.097 | 9.132 | 8.165 | 10.371 | 8.215 | 7.942 |
| C16 | 7.796 | 6.848 | 7.591 | 6.071 | 7.456 | 5.665 | 7.557 | 7.900 | 8.374 | 9.387 | 8.603 | 8.734 | 6.491 | 6.458 | 8.577 | 8.582 | 10.129 | 8.980 | 7.723 | 7.885 | 9.327 | 9.346 | 9.375 | 8.694 | 8.275 | 10.240 | 9.851 | 7.452 | 9.641 | 8.612 | 10.963 | 8.661 | 8.351 |
| C17 | 7.106 | 6.224 | 6.950 | 5.519 | 6.745 | 5.187 | 6.968 | 7.256 | 7.719 | 8.562 | 7.853 | 8.015 | 5.904 | 5.865 | 7.842 | 7.863 | 9.191 | 8.087 | 7.027 | 7.267 | 8.394 | 8.517 | 8.499 | 7.943 | 7.713 | 9.141 | 8.951 | 6.668 | 8.706 | 7.763 | 9.833 | 7.764 | 7.595 |
| C18 | 1.337 | 1.189 | 1.279 | 1.151 | 1.312 | 1.135 | 1.206 | 1.208 | 1.322 | 1.557 | 1.404 | 1.446 | 1.083 | 1.041 | 1.376 | 1.403 | 1.643 | 1.770 | 1.366 | 1.321 | 1.641 | 1.616 | 1.584 | 1.449 | 1.329 | 1.625 | 1.573 | 1.172 | 1.576 | 1.431 | 1.773 | 1.416 | 1.398 |
| C19 | 4.169 | 3.715 | 4.038 | 3.400 | 4.038 | 3.183 | 3.757 | 3.918 | 4.224 | 4.879 | 4.442 | 4.547 | 3.291 | 3.196 | 4.369 | 4.417 | 5.174 | 4.796 | 4.111 | 3.986 | 4.948 | 4.929 | 4.908 | 4.466 | 4.172 | 5.108 | 5.007 | 3.665 | 4.994 | 4.394 | 5.559 | 4.375 | 4.318 |
| C20 | 4.023 | 3.538 | 3.942 | 3.068 | 3.768 | 2.886 | 3.891 | 4.039 | 4.260 | 4.774 | 4.405 | 4.487 | 3.233 | 3.154 | 4.323 | 4.343 | 5.192 | 4.425 | 3.880 | 4.029 | 4.645 | 4.715 | 4.736 | 4.414 | 4.200 | 4.968 | 4.901 | 3.595 | 4.818 | 4.357 | 5.358 | 4.217 | 4.206 |
| C21 | 7.086 | 6.233 | 6.867 | 5.548 | 6.791 | 5.224 | 6.707 | 7.001 | 7.447 | 8.374 | 7.698 | 7.854 | 5.692 | 5.582 | 7.587 | 7.639 | 9.033 | 8.093 | 6.900 | 7.085 | 8.287 | 8.421 | 8.399 | 7.733 | 7.354 | 8.870 | 8.677 | 6.419 | 8.541 | 7.634 | 9.582 | 7.553 | 7.435 |
| C22 | 7.208 | 6.357 | 7.115 | 5.607 | 6.821 | 5.304 | 6.988 | 7.270 | 7.697 | 8.626 | 7.883 | 8.056 | 5.824 | 5.792 | 7.789 | 7.819 | 9.263 | 8.249 | 6.988 | 7.279 | 8.459 | 8.556 | 8.624 | 8.013 | 7.565 | 9.015 | 8.931 | 6.529 | 8.688 | 7.967 | 9.795 | 7.725 | 7.619 |
| C23 | 7.532 | 6.586 | 7.439 | 5.864 | 7.187 | 5.542 | 7.287 | 7.581 | 8.008 | 9.015 | 8.248 | 8.432 | 6.100 | 6.049 | 8.140 | 8.177 | 9.730 | 8.628 | 7.337 | 7.653 | 8.875 | 9.017 | 8.964 | 8.368 | 7.896 | 9.494 | 9.328 | 6.828 | 9.123 | 8.326 | 10.289 | 8.104 | 7.973 |
| C24 | 6.759 | 5.973 | 6.697 | 5.256 | 6.429 | 4.952 | 6.653 | 6.914 | 7.318 | 8.158 | 7.455 | 7.623 | 5.581 | 5.539 | 7.441 | 7.465 | 8.805 | 7.710 | 6.611 | 6.942 | 7.988 | 8.140 | 8.167 | 7.575 | 7.276 | 8.618 | 8.498 | 6.248 | 8.243 | 7.555 | 9.332 | 7.413 | 7.229 |
| C25 | 5.467 | 4.819 | 5.380 | 4.287 | 5.224 | 4.009 | 5.527 | 5.798 | 6.156 | 6.728 | 6.206 | 6.331 | 4.726 | 4.706 | 6.269 | 6.243 | 7.311 | 6.265 | 5.448 | 5.773 | 6.498 | 6.654 | 6.644 | 6.263 | 6.192 | 7.248 | 7.091 | 5.402 | 6.846 | 6.100 | 7.752 | 6.178 | 5.986 |
| C26 | 6.366 | 5.570 | 6.187 | 4.929 | 6.027 | 4.548 | 6.246 | 6.527 | 6.886 | 7.717 | 7.046 | 7.196 | 5.389 | 5.362 | 7.081 | 7.136 | 8.348 | 7.460 | 6.331 | 6.521 | 7.579 | 7.641 | 7.665 | 7.134 | 6.894 | 8.391 | 8.104 | 6.245 | 7.927 | 7.087 | 9.007 | 7.157 | 6.866 |
| C27 | 6.311 | 5.543 | 6.209 | 5.041 | 6.027 | 4.735 | 6.191 | 6.441 | 6.830 | 7.638 | 6.958 | 7.168 | 5.271 | 5.233 | 6.984 | 7.007 | 8.228 | 7.314 | 6.294 | 6.509 | 7.438 | 7.547 | 7.539 | 7.047 | 6.907 | 8.273 | 7.952 | 6.047 | 7.815 | 6.979 | 8.836 | 7.034 | 6.792 |
| C28 | 4.160 | 3.607 | 4.068 | 3.110 | 3.856 | 2.878 | 4.427 | 4.689 | 4.949 | 5.271 | 4.781 | 4.848 | 3.970 | 3.996 | 5.020 | 5.004 | 5.635 | 4.907 | 4.238 | 4.345 | 5.006 | 5.080 | 5.065 | 4.827 | 4.974 | 5.940 | 5.680 | 4.601 | 5.342 | 4.702 | 6.256 | 5.012 | 4.695 |
| C29 | 6.738 | 5.865 | 6.510 | 5.234 | 6.346 | 4.861 | 6.392 | 6.633 | 7.011 | 7.933 | 7.320 | 7.495 | 5.360 | 5.320 | 7.187 | 7.231 | 8.605 | 7.642 | 6.502 | 6.703 | 7.782 | 7.892 | 7.911 | 7.292 | 7.048 | 8.508 | 8.241 | 6.185 | 8.124 | 7.242 | 9.143 | 7.216 | 7.046 |
| C30 | 6.039 | 5.257 | 5.994 | 4.677 | 5.671 | 4.356 | 5.937 | 6.099 | 6.438 | 7.231 | 6.548 | 6.739 | 4.858 | 4.891 | 6.509 | 6.561 | 7.763 | 6.807 | 5.860 | 6.079 | 7.023 | 7.152 | 7.157 | 6.682 | 6.398 | 7.724 | 7.518 | 5.521 | 7.353 | 6.644 | 8.307 | 6.537 | 6.385 |
| C31 | 6.704 | 5.903 | 6.600 | 5.314 | 6.373 | 4.969 | 6.703 | 6.989 | 7.367 | 8.172 | 7.455 | 7.589 | 5.698 | 5.687 | 7.457 | 7.488 | 8.788 | 7.850 | 6.632 | 6.951 | 7.974 | 8.039 | 8.040 | 7.552 | 7.393 | 8.852 | 8.591 | 6.523 | 8.319 | 7.454 | 9.453 | 7.480 | 7.261 |
| C32 | 6.187 | 5.416 | 6.088 | 4.778 | 5.843 | 4.450 | 6.258 | 6.527 | 6.864 | 7.632 | 6.965 | 7.131 | 5.375 | 5.414 | 6.980 | 6.998 | 8.197 | 7.230 | 6.124 | 6.380 | 7.325 | 7.439 | 7.449 | 6.955 | 6.903 | 8.385 | 8.038 | 6.281 | 7.779 | 6.952 | 8.961 | 7.056 | 6.761 |
| α | 5.901 | 5.175 | 5.778 | 4.629 | 5.627 | 4.328 | 5.706 | 5.929 | 6.293 | 7.077 | 6.475 | 6.624 | 4.832 | 4.804 | 6.426 | 6.462 | 7.619 | 6.800 | 5.795 | 5.989 | 6.965 | 7.047 | 7.052 | 6.539 | 6.268 | 7.575 | 7.360 | 5.494 | 7.228 | 6.495 | 8.145 | 6.435 | |

Table 8. Antecedent matrix

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 | C29 | C30 | C31 | C32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| C32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |

Table 9. Intersection set

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 | C29 | C30 | C31 | C32 | Frequency | Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **17** | **2** |
| C2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **17** | **2** |
| C3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **17** | **2** |
| C4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **17** | **2** |
| C11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| C29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **18** | **3** |
| C30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |
| C32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **19** | **4** |

**Figures**

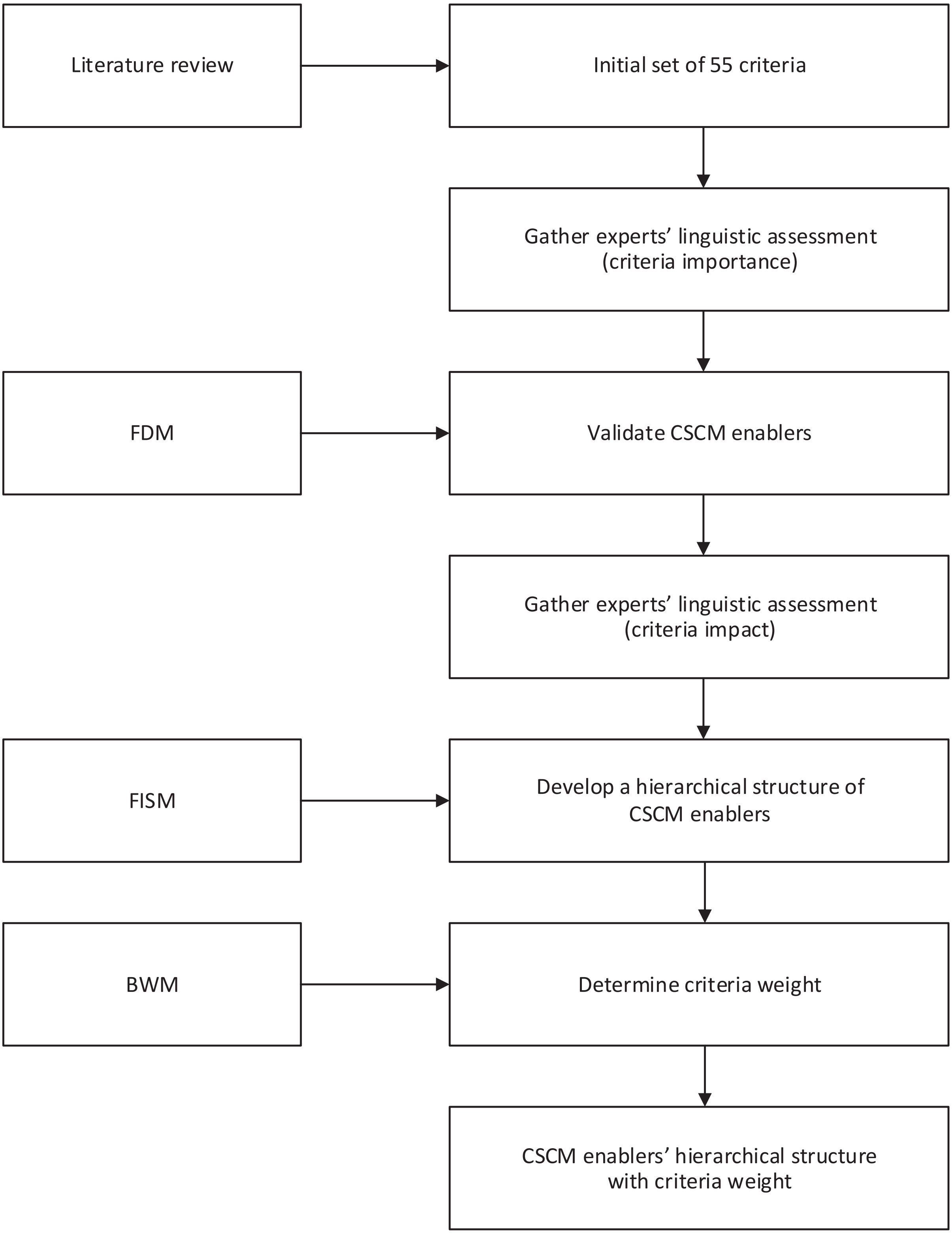


Figure 1. Flowchart of methodology

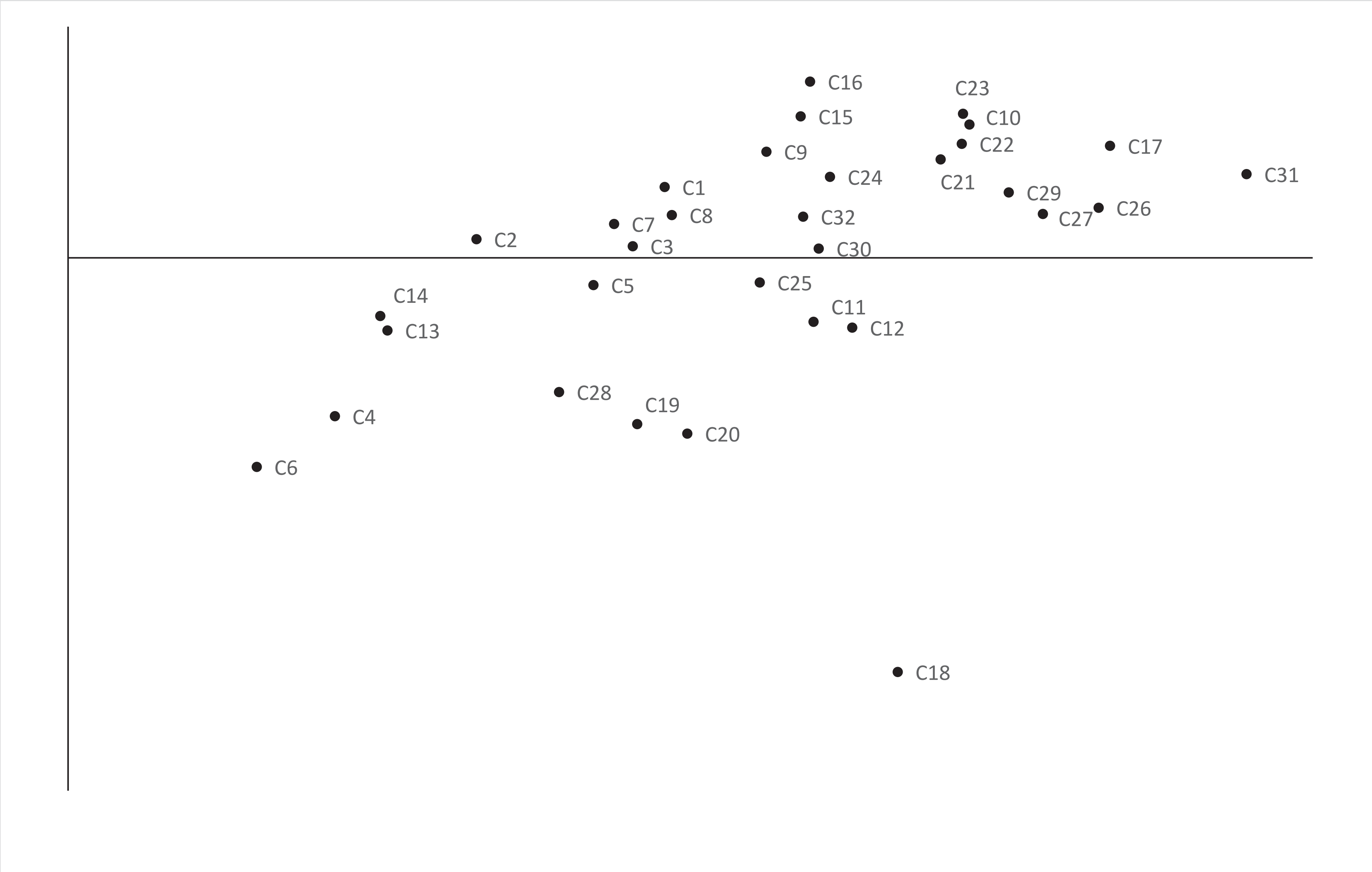


Figure 2. Cause and effect diagram for criteria

| Level | | | Criteria | Weight | Rank | Consistency |
|---|---|---|---|---|---|---|
| **4** | Organizational capability and agility | Organizational capability | C17: Suppliers' collaboration | 0.4554 | 1 | 0.0297 |
| | | | C24: Implementation of information technologies | 0.0495 | 4 | |
| | | | C31: Commitment of leadership and managerial support | 0.4257 | 2 | |
| | | | C32: Employees' engagement | 0.0693 | 3 | |
| | | Agility | C26: Firm culture | 0.0588 | 1 | 0.0735 |
| | | | C27: Readiness for organizational change | 0.6029 | 2 | |
| | | | C30: Lean tools | 0.3382 | 3 | |
| **3** | Technology advancement and economic motivation | Technology advancement | C21: Cleaner technology | 0.6029 | 1 | 0.0735 |
| | | | C22: Technology infrastructure | 0.0588 | 3 | |
| | | | C23: Technology competence | 0.3382 | 2 | |
| | | Economic motivation | C7: Cost reduction | 0.2529 | 1 | 0.0399 |
| | | | C8: Revenue gains | 0.2795 | 2 | |
| | | | C9: Competitive advantage | 0.2529 | 3 | |
| | | | C15: Brand protection | 0.0266 | 6 | |
| | | | C16: Improve green image and reputation | 0.1464 | 4 | |
| | | | C29: Sustainability concept integration | 0.0418 | 5 | |
| **2** | Environmental benefit | | C1: Minimize waste generation | 0.0547 | 1 | 0.0684 |
| | | | C2: Resource conservation | 0.0699 | 4 | |
| | | | C3: Save energy | 0.3146 | 3 | |
| | | | C10: Sustainable business and growth | 0.5608 | 2 | |
| **1** | Corporate social responsibility and stakeholders' pressures | Corporate social responsibility | C4: Resource scarcity | 0.0561 | 1 | 0.0467 |
| | | | C5: Possibilities to prevent negative environmental impacts | 0.0561 | 5 | |
| | | | C6: Climate change | 0.0374 | 7 | |
| | | | C11: Value recovery | 0.0654 | 4 | |
| | | | C12: Integration of manufacturing and remanufacturing operations | 0.3458 | 3 | |
| | | | C13: Healthy and safe working conditions | 0.3832 | 2 | |
| | | | C14: Wages and benefit | 0.0561 | 6 | |
| | | Stakeholders' pressures | C18: Government regulation and support | 0.6316 | 1 | 0.1263 |
| | | | C19: Customers' awareness | 0.0632 | 5 | |
| | | | C20: International competition | 0.1263 | 2 | |
| | | | C25: Information sharing | 0.0842 | 4 | |
| | | | C28: Mutual trust and respect | 0.0947 | 3 | |

Figure 3. Hierarchical structure

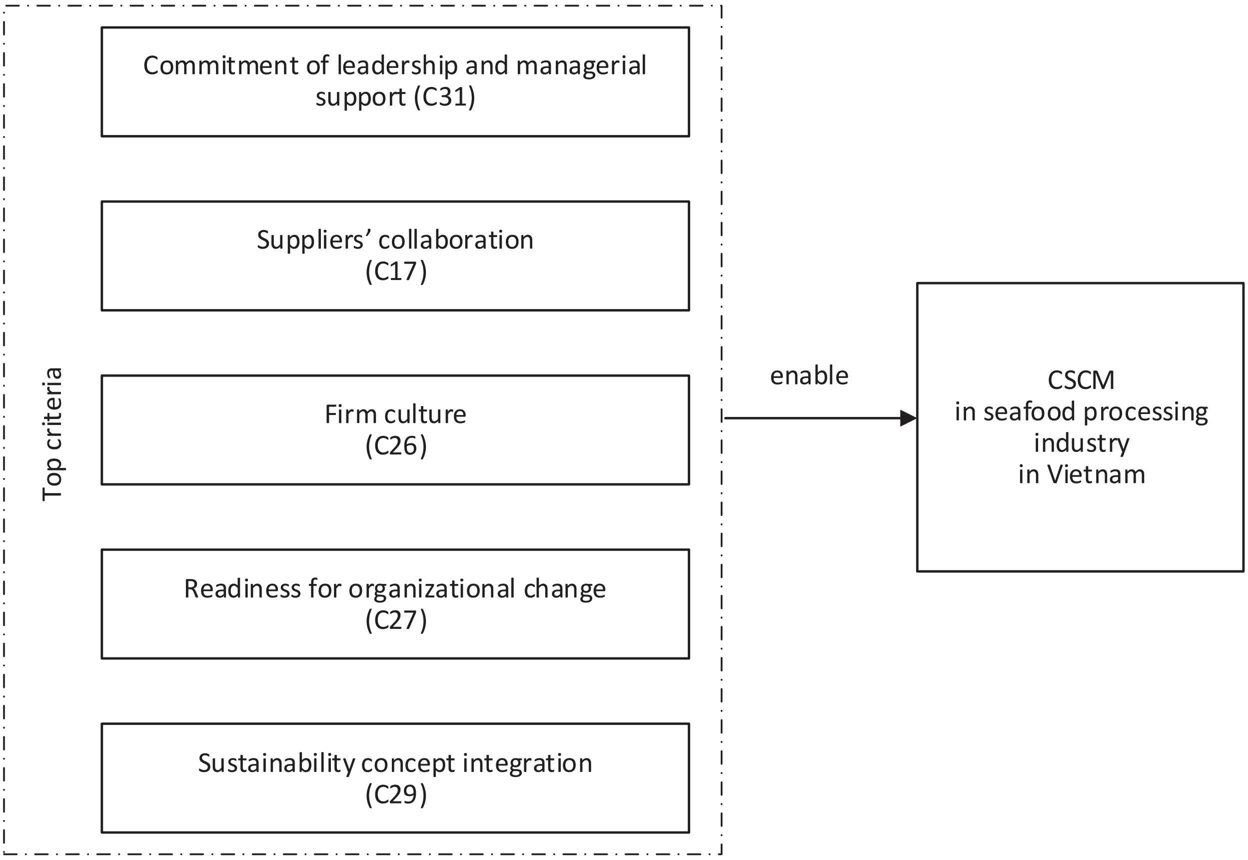


Figure 4. Top criteria for practical implementation

**Appendix**

Appendix 1. FDM screening out for criteria

| | Initial criteria | $p_x$ | $v_x$ | $E_x$ | Decision |
|---|---|---|---|---|---|
| O1 | Minimize waste generation | (0.306) | 0.806 | 0.537 | Accepted |
| O2 | Resource conservation | (0.306) | 0.806 | 0.537 | Accepted |
| O3 | Low carbon footprints | 0.000 | 0.500 | 0.333 | Unaccepted |
| O4 | Save energy | 0.046 | 0.828 | 0.635 | Accepted |
| O5 | Low landfills | 0.000 | 0.500 | 0.333 | Unaccepted |
| O6 | Reduced consumption of raw/virgin material | 0.000 | 0.500 | 0.333 | Unaccepted |
| O7 | Resource scarcity | (0.285) | 0.785 | 0.523 | Accepted |
| O8 | Possibilities to prevent negative environmental impacts | (0.302) | 0.802 | 0.535 | Accepted |
| O9 | Climate change | (0.263) | 0.763 | 0.508 | Accepted |
| O10 | ISO 14001 certification | 0.000 | 0.500 | 0.333 | Unaccepted |
| O11 | Recovery capability | 0.000 | 0.500 | 0.333 | Unaccepted |
| O12 | Integration capability | 0.000 | 0.500 | 0.333 | Unaccepted |
| O13 | Manufacturing capability | 0.000 | 0.500 | 0.333 | Unaccepted |
| O14 | Cost reduction | 0.023 | 0.851 | 0.651 | Accepted |
| O15 | Revenue gains | (0.008) | 0.883 | 0.672 | Accepted |
| O16 | Financial opportunities | 0.000 | 0.500 | 0.333 | Unaccepted |
| O17 | Competitive advantage | 0.013 | 0.861 | 0.657 | Accepted |
| O18 | Sustainable business and growth | (0.017) | 0.892 | 0.678 | Accepted |
| O19 | Quality product | 0.000 | 0.500 | 0.333 | Unaccepted |
| O20 | Value recovery | 0.046 | 0.828 | 0.635 | Accepted |
| O21 | Market for recovered products | 0.000 | 0.500 | 0.333 | Unaccepted |
| O22 | Integration of manufacturing and remanufacturing operations | 0.037 | 0.837 | 0.641 | Accepted |
| O23 | Healthy and safe working conditions | 0.002 | 0.872 | 0.665 | Accepted |
| O24 | Job creation potential | 0.000 | 0.500 | 0.333 | Unaccepted |
| O25 | Ethics and values | 0.000 | 0.500 | 0.333 | Unaccepted |
| O26 | Wages and benefit | 0.050 | 0.824 | 0.632 | Accepted |
| O27 | Brand protection | (0.306) | 0.806 | 0.537 | Accepted |
| O28 | Improve green image and reputation | 0.046 | 0.828 | 0.635 | Accepted |
| O29 | Suppliers' collaboration | 0.037 | 0.837 | 0.641 | Accepted |
| O30 | Government regulation and support | 0.375 | 0.875 | 0.750 | Accepted |
| O31 | Customers' awareness | (0.337) | 0.837 | 0.558 | Accepted |
| O32 | Experts' involvement | 0.000 | 0.500 | 0.333 | Unaccepted |
| O33 | Community pressure | 0.000 | 0.500 | 0.333 | Unaccepted |
| O34 | International competition | 0.084 | 0.790 | 0.610 | Accepted |
| O35 | Blockchain | 0.000 | 0.500 | 0.333 | Unaccepted |
| O36 | Big data | 0.000 | 0.500 | 0.333 | Unaccepted |

| | | | | | |
|---|---|---|---|---|---|
| O37 | Internet of Things | 0.000 | 0.500 | 0.333 | Unaccepted |
| O38 | Cleaner technology | (0.328) | 0.828 | 0.552 | Accepted |
| O39 | Technology infrastructure | (0.294) | 0.794 | 0.529 | Accepted |
| O40 | Technology competence | (0.318) | 0.818 | 0.545 | Accepted |
| O41 | Implementation of information technologies | (0.302) | 0.802 | 0.535 | Accepted |
| O42 | Information sharing | (0.318) | 0.818 | 0.545 | Accepted |
| O43 | Skilled labor | 0.000 | 0.500 | 0.333 | Unaccepted |
| O44 | Education and training system | 0.000 | 0.500 | 0.333 | Unaccepted |
| O45 | Firm culture | (0.274) | 0.774 | 0.516 | Accepted |
| O46 | Readiness for organizational change | (0.315) | 0.815 | 0.543 | Accepted |
| O47 | Mutual trust and respect | (0.347) | 0.847 | 0.565 | Accepted |
| O48 | Teamwork | 0.000 | 0.500 | 0.333 | Unaccepted |
| O49 | Sustainability concept integration | (0.337) | 0.837 | 0.558 | Accepted |
| O50 | Lean tools | (0.306) | 0.806 | 0.537 | Accepted |
| O51 | Flexibility | 0.000 | 0.500 | 0.333 | Unaccepted |
| O52 | Firms’ policy and mission | 0.000 | 0.500 | 0.333 | Unaccepted |
| O53 | Department integration | 0.000 | 0.500 | 0.333 | Unaccepted |
| O54 | Commitment of leadership and managerial support | 0.059 | 0.815 | 0.626 | Accepted |
| O55 | Employees’ engagement | (0.333) | 0.833 | 0.555 | Accepted |
| Threshold | | | | 0.482 | |

Appendix 2. Expert biographical information

| Expert | Position | Education levels | Years of experience | Organization types (Academic/Practice) |
|---|---|---|---|---|
| 1 | Lecturer | Master | 18 | Academic |
| 2 | Lecturer | PhD | 16 | Academic |
| 3 | Lecturer | PhD | 17 | Academic |
| 4 | Lecturer | PhD | 12 | Academic |
| 5 | Lecturer | Master | 16 | Academic |
| 6 | Lecturer | PHD | 16 | Academic |
| 7 | Lecturer | PhD | 17 | Academic |
| 8 | Manager | Bachelor | 11 | Practice |
| 9 | Manager | Master | 10 | Practice |
| 10 | Staff | Master | 10 | Practice |
| 11 | Manager | Master | 12 | Practice |
| 12 | Manager | PhD | 15 | Practice |
| 13 | Manager | Bachelor | 29 | Practice |
| 14 | Manager | Master | 10 | Practice |