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Article

Understanding Innovation for Sustainable Business Management Capabilities and Competencies under Uncertainty

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Abstract: In recent years, many firms have come to understand that innovation is an important issue in sustainable business management, as it helps improve firm capabilities and competencies. Because of the fiercely competitive environment in the hotel industry, innovation has become a critical factor in the process of hotel differentiation, leading to sustainable business success. However, the literature has not thoroughly examined the role of innovation or the hierarchical structure of the capabilities and competencies in sustainable business management. This study adopts interval-valued triangular fuzzy numbers and grey relational analysis to provide a competitive priority ranking for the aspects and criteria that assist firms in decision-making. The study results indicate that innovation in technology capabilities and networking and social capabilities—in addition to competencies in systemic thinking—are the most important aspects of sustainable business management. In particular, this study indicates that to succeed in building a sustainable business in the hotel industry, firms should upgrade and integrate their business technologies, collaborate with actors inside and outside the firm, build trust as well as a shared vision that includes common agreement, and develop competencies in inventive thinking to support innovation and foster changes in strategy, structure, administrative procedures, and systems when necessary.

Keywords: sustainable business management; innovation; capabilities and competences; interval-valued triangular fuzzy numbers; grey relational analysis

1. Introduction

In the era of globalization, the hotel industry has become more cut-throat as a result of increased competition from more firms [1–3]. To compete, hotels must enhance their capabilities and competencies to improve operational performance in myriad ways as judged under various criteria. Thus, hotels must apply new technologies to track and respond to customer demands and achieve sustainability [3,4]. Sustainability will be achieved based on innovation in response to customer needs for new services and products, which will lead to increased market share and profits and will also contribute to business sustainability [5–7]. However, innovation involves increased risk, and success is not guaranteed; to enjoy a higher likelihood of success in innovation, thorough assessments must be undertaken and value-creating investments must be chosen [8–11].

In the literature, innovation is considered an important element of firm success [12]. Harper and Becker [13] indicated that innovation resulted in significant change—preferably an improvement in the real product, process, or service—that exceeds the impact of previous achievements; these authors further indicated that innovation supported sustainable business management. Firms encourage innovation to achieve production and marketing goals, to improve product or service quality, to lower their operational costs, to increase their market share, to attain production flexibility, and to improve the management process [14]. Previous studies have generally indicated that innovation was positively associated with business sustainability [15,16]. However, Zahra [17] and Colquitt *et al.* [18] also noted that innovation may be a risky investment; developing and launching new products and/or services is necessary for firm survival and sustainability, but these are costly business processes. Delgado [19] argued that the positive effects of innovation, particularly technology innovation, may be exaggerated, whereas the potential negative effects are typically ignored or underemphasized. Hence, it is critical to understand and properly manage firm capabilities and competencies to minimize and avoid risky investments in innovation.

Innovation supports management by introducing new services, products, and improvements in quality [5]; thus, innovation has significantly influenced business outcomes by enhancing the competitiveness and sustainability of businesses [20]. Nonetheless, Hjalager [9] noticed a gap between innovation and sustainable business; thus, the manner in which innovation assists sustainable business management must be investigated to gain greater and deeper insights for hotel managers. In addition, sustainable business management capabilities and competencies (SBMCC) must be identified and utilized to promote innovation efficiency and effectiveness and to enable firms to enjoy and foster a sustainable business [21,22]. This study suggests that technology capabilities play an important role in innovation, and the readiness to upgrade and integrate new technology can enable innovation for product and service development, marketing, and even for management processes. Moreover, networking and social capabilities were determined to be important in gathering and sharing knowledge, which assists a firm's innovation output by enabling innovative collaboration [23–25].

Certain measures play a significant role in defining and illuminating SBMCC because the complex, limited, and diverse information available regarding SBMCC has led to incomplete and vague descriptions of the notion. Moreover, these measures have provided qualitative information and linguistic descriptions, as well as incomplete information, from firms. In particular, imprecise information has resulted because of situations in which there are insufficient data and the data pattern remains unknown [26,27]. Therefore, this evaluation system would be well-served by applying a classic grey system. In addition, this study must utilize experts' subjective opinions, assigning them relative weights, and combining them with grey relation analysis (GRA) to evaluate and understand the important aspects and criteria of particular firms. To identify the relative weights of the proposed aspects and criteria is an important part of this approach, and this study applies interval-valued triangular fuzzy numbers (IVTFN) for the subjective approaches. To overcome the shortcomings discussed above, this study proposes IVTFN and GRA together to shed additional light on SBMCC in firms. Finally, achieving a sustainable business requires capabilities and competencies to understand the innovation activities. Hence, the objective of this study is to investigate the contributions of innovation criteria to SBMCC under uncertainty and to demonstrate the effects on SBMCC when there is incomplete information. Accordingly, this study is organized as follows. First, innovation and its relationship with SBMCC are presented. In Section 2, the theory adopted is discussed. Section 3 presents the methods. The results are discussed in Section 4. Section 5 presents the theoretical and managerial implications. The last section concludes and discusses the limitations of this study.

2. Literature Review

This section reviews the definitions and the role of innovation in SBMCC. The subsection review emphasizes the following specific areas: innovation, SBMCC, the proposed method, and the development of the proposed measures.

2.1. Innovation

Van Kleef and Roome [21] defined "innovation as the process of discovery and development that generates new products, production processes, organizations, technology, and institutional and systemic arrangements". This definition includes employing ideas, knowledge, and technology in a manner that enables firms to significantly improve performance. Onsel *et al.* [28] indicated that innovation is not necessarily related to problem-solving but is instead typically related to improving competitiveness and economic success—and it is frequently spurred by technology. The previous literature distinguished the different types of innovation as technology, process, product and service, management, operations, and organization [29,30].

Innovation was viewed as supporting businesses in a variety of ways, such as in product and service innovation; technological innovation can increase the efficiency and effectiveness of a firm's operations, whereas organizational innovation can promote growth in productivity and competitiveness by encouraging the application of new technologies [31]. Several studies have indicated that innovation is directly or indirectly linked to the sustainable business management of a firm [32,33]. Hence, the contributions of innovation to sustainable business management might be implemented by utilizing and developing firm capabilities and competencies [21]. However, capability and competency problems also have affected

innovation activities. Van de Ven and Engleman [34] noted the problem of managing networking and social capabilities; innovative ideas arise from different areas inside or outside a firm, and multiple functions and resources within a corporation are necessary to transform an innovative idea into reality.

2.2. Innovation for Sustainable Business Management Capabilities and Competencies

Van Kleef and Roome [21] defined sustainable business management as "the management of sustainable business that recognizes its embeddedness in social, environmental and economic systems and focuses on management and relationships to meet the environmental, social, and economic requirements of the many different stakeholders in its networks". Recently, innovation for sustainable business management has received an increasing amount of attention from management [35], as innovation is increasingly recognized as an important means to contribute to sustainability [36,37]. However, people and firms tend to focus on and take advantage of existing practices rather than exploring new ideas, needs, and opportunities for innovation; thus, it is difficult to encourage innovation in these cases [34]. Hence, there is an essential need for firms to explore the insights of capabilities and competencies to drive innovation.

Dutta *et al.* [38] considered capability as the ability to transform resources into objectives, which relates to performing a set of synchronizing tasks and utilizing resources to attain a particular result. These results offer an individual or an entire organization the ability to construct the building blocks of business competencies [21]. Thus, competencies are combinations of knowledge, experience, and productive attributes, in addition to being accurate combinations of functional and technical skills to perform the tasks, solve problems, and operate effectively under uncertainty [39–42]. Competencies are also represented in the entirety of the firm, which contains the contribution of employees, alignments within the firm, and the value added to customers and stakeholders. These attributes allow firms to create new products and services while adapting to changing circumstances faster than competitors and thus enhancing their competiveness [5].

This study extends the definition of SBMCC from van Kleef and Roome [21]: "Sustainable business management builds embeddedness capabilities and competencies by addressing the social, environmental and economic systems and focuses on innovation and relationships to meet the different stakeholder requirements in its networks". Ensuring that innovation competencies are present in the key roles within a firm and that these competencies are used to build internal capabilities at all levels is also essential to the pursuit of business sustainability [42–44]. In particular, innovation yields benefits to SBMCC by leveraging those capabilities and competencies that enable firms to build cost efficiencies and operational effectiveness to compete in a sustainable business environment. To enhance the understanding in this field, this study proposes five aspects by which to identify SBMCC: (1) technological capabilities; (2) networking and social capabilities; (3) learning and developing capabilities; (4) competencies for systemic thinking; and (5) capabilities for integrating business, environmental/social problems, perspectives and information.

2.3. Proposed Method

Previous studies have focused on applying classical statistical methods in addressing sustainable business management [45,46]. Few studies have considered SBMCC as a multiple criteria problem to identify its importance by adopting linguistic variables and providing sufficient results. Within the

identification, linguistic variables rely on expert opinions and contain vagueness, imprecision, and uncertainties [47]. Hence, IVTFN is proposed in this study to overcome these situations and to convert the linguistic variables into quantitative evaluations. Therefore, the computation of the geometric mean is taken as the membership degree to derive the statistical unbiased effect and avoid the impact of extreme values. The advantage of this method is the simplicity that results from all the expert opinions being contained in one investigation and that aggregates the evaluations from diverse perspectives. Once the fuzzy decision matrix is obtained, the GRA must arrange to address the incomplete system information.

GRA was developed by Deng [48] to identify the relation between two sequences. This method is suggested as an instrument for solving the multiple criteria problem, which enables us to find solutions from a finite set of aspects and criteria under incomplete information [26,27,49]. The basic principle is that if a comparability sequence translated from a criterion has the highest grey relational grade among the reference sequence, it represents the best choice. All the criteria can be ranked upon the grey relational grade, which will help the decision-maker in handling a multi-criteria decision-making problem. This study integrated IVTFN and GRA to illuminate the relationship between innovations and SBMCC. The criteria are formed as linguistic variables and expressed in IVTFN, then GRA is used to determine the ranking of aspects and criteria under incomplete information [50].

2.4. Proposed SBMCC Measures

The previous literature has been used to identify the capabilities and competencies required to innovate for competitive purposes in sustainable business management [21,42–44]. However, previous studies in the field of innovation have discussed these capabilities and competencies separately, which include systems thinking; learning and developing; networking and social capabilities; integrating business, environmental, information and social problems; and technology (as shown in Table 1). A comprehensive study is required to aggregate all as a whole to understand how these capabilities and competencies can lead to innovation for sustainable business management. Hence, the multi-criteria approach is adopted in this study to derive the significant implications resulting from our approach.

Systems thinking is a new concept in addressing competencies; accordingly, product invention, creativity, processes and/or business models require firm personnel to learn from experience in terms of both practice and theory to contribute to job performance and new firm projects [21,51,52]. Moreover, systems thinking can utilize multi-theories and techniques to build holistic, contingent perspectives and practices [53–55]. Independent thinking creates diversity and the potential to contribute to organizational learning and to address complexity [52,56]—the individual is the building block in the development of diverse skills and competencies [21,57]. However, teammates who have developed their own specific abilities and inventive strategies may increase the possibility of bringing ideas together to solve problems [58].

Table 1. Proposed innovation measures for sustainable business management capabilities and competencies.

Aspects		Criteria
Competencies for systems thinking (AS1)	C1	The competency to think independently
	C2	Expertise in organization design will be a critical skill—how to analyze, modify and simulate the behavior of complex human systems
	C3	A powerful tool to facilitate both individual and organizational learning
	C4	Product life-cycle management systems offer core innovation competencies
	C5	The competency to think inventively
	C6	Grasping manufacturing cycle time will improve on-time delivery, product quality and cost
Networking and social capabilities (AS2)	C7	To gather and review the alternative strategies of each stakeholder
	C8	To build trust, a shared vision and agreement on basic values
	C9	To develop social relations with unfamiliar actors inside or outside the organization for information gathering, experimentation and negotiation purposes
	C10	To involve many stakeholders from the start (e.g., local communities, regional, state or national stakeholders, supply chain partners, and buyers)
	C11	To co-operate with universities/research institutes, to develop brand new ideas
	C12	To participate in industrial networks such as industrial associations, standard organizations and industrial forums
Technology capabilities (AS3)	C13	New approaches to developing knowledge for performing management functions and new processes that produce changes in the organization's strategy, structure, administrative procedures, and systems
	C14	To upgrade and integrate technology capabilities, new product development and marketing
	C15	Using existing technology
	C16	Adoption of electronic data processing for a variety of internal information storage, retrieval and analytical purposes, indirectly related to the basic work activity of the firm and more immediately related to its management
	C17	Quantum leaps in performance
	C18	To define technology that could help
Capabilities for learning and developing (AS4)	C19	To learn and translate learning into action
	C20	Typically adopt new ideas and develop them as reliable products
	C21	To effectively address the requirements, values, assumptions and cultures of various interacting network actors
	C22	To develop insights and observe what local community does, how they think, what they need and want
	C23	To encourage cross-functional learning and fertilization
	C24	To successfully understand and execute innovation activities with the network
Capabilities for integrating business, environmental, information and social problems. (AS5)	C25	To integrate the perspectives and knowledge of different actors in the network
	C26	To integrate traditional criteria of efficiency with eco- and social-efficiency and effectiveness
	C27	To integrate one or two socio-environmental indicators into a single perspective
	C28	To apply the knowledge gained in previous projects to new projects
	C29	To integrate differences in information processing and decision styles, to address differences in the width of focus and the desired degree of maximization of the result
	C30	To identify the business problem and constraints (time, resources, market)

Source from: [21,51,59,60–62].

In the case of learning and developing, different actors in the networks provide greater potential for learning and are necessary to evoke the potential solutions to solve complex issues [63,64]. These actors are internal and external to the firm and develop insights and observe what the local community does, how individual members think, and what they need and want; these actors understand and execute innovation activities within the network by developing knowledge and forming new innovation networks [61,63]. Although all the firms aim to reach this level, most encounter difficulties in the basic practice that requires collaboration in various business and management functions, such as marketing affiliations and certification schemes aligning to promote environmental awareness and education as well as new product development and innovation [65].

For a firm, competitive advantage not only is dependent on research and development but also is enhanced by potential technology [60,66]. In reality, most of the firm is unable to have up-to-date technology developed in-house because of the increasingly complex nature of technology and short product life cycles. If a firm wants to remain competitive in the market, it must quickly integrate, adopt, and upgrade the diversity of its external and internal information storage, retrieval, and analytical tools that relate to basic work activities—in addition to business and management functions—with external technologies and on-time product launches [21,60]. Therefore, searching for the internal factors that encourage technological innovation capabilities might augment the understanding of innovative processes in the firm [67,68].

Some sustainable actions involve collective problem solving, system development, technological progress, and other innovations that are identified with achieving business goals. These stages can be presented in the open processes of innovation and can input the implementation into a broad range of stakeholders. Hence, the social networks offer a platform for individuals and stakeholders in a community to reference, gather, and exchange ideas, information, experimentation, and negotiation [69]. Although these platforms can be designed for searching opportunities, it remains insufficient to discuss the sustainability issues currently [21,65]. Thus, firms require a strategy that is compatible with integrating into these platforms and with these stakeholders, that creates competitive advantages such as cost reductions and favorable future market positions, and that benefits the firm by enabling it to acquire increased legitimacy through collaborations with external stakeholders in a community [70].

Dyllick and Hockerts [71] have suggested that sustainable business management requires the concept of efficiency (the economic value added in relation to the aggregate resources used) to be extended to eco-efficiency and socio-efficiency (the economic value added in relation to the aggregated ecological and social impacts, respectively). In addition, concepts such as eco-effectiveness and socio-effectiveness have been suggested as ways to address the absolute thresholds in social and ecological sustainability [72]. The European Commission [73] has suggested that efficiency might be complemented or replaced by the notion of sufficiency. Deciding upon the size and character of social and environmental thresholds and determining sufficiency criteria are understood to require inputs from actors outside of firms as units of production [65,74].

3. Method

GRA was initially proposed by Deng [75] to overcome the insufficient information among systems. In addition, IVTFN was used to assist decision-makers in the precise evaluation of subjects. This study

integrates GRA and IVTFN to explore the important aspects and criteria for building sustainability under uncertainty. The method and proposed analytical steps are described below.

3.1. Interval-Valued Triangular Fuzzy Numbers with Grey Relational Analysis

Consider a decision-making problem with i aspects and j criteria; then, let $\alpha = \{\alpha_1, \alpha_2, \cdots, \alpha_i\}$ and $\beta = \{\beta_1, \beta_2, \cdots, \beta_j\}$ be a finite set of feasible aspects and criteria, respectively. Although the weightage of criteria $v = (v_1, v_2, \cdots v_j)$ is unknown, it must satisfy $v_j \geq 0, j = 1,2, \cdots n, \sum_{j=1}^{n} v_j = 1$. Assume that the performance β_j related to aspect α_i is defined as s_{ij}; then, the decision matrix can be presented by $S = [s_{ij}]_{m \times n}$. According to the illustration of Figure 1, s_{ij} can be rewritten as IVTFN $s' = \begin{cases} (s_1, s_2, s_3) \\ (\tilde{s}_1, s_2, \tilde{s}_3) \end{cases}$ and is also expressed as $s' = [(s_1, \tilde{s}_1); s_2; (\tilde{s}_3, s_3)]$.

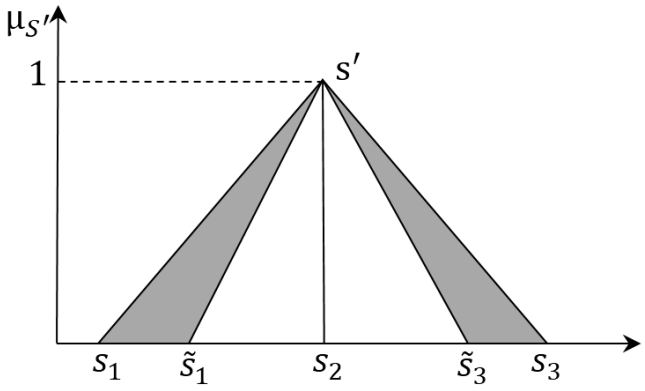

Figure 1. An interval-valued triangular fuzzy number.

The proposed IVTFN-GRA method is associated with an unknown weightage vector and calculated by the following procedures. First, normalize the decision matrix S, which consists of $s'_{ij} = \left[\left[(x_{ij}, \tilde{x}_{ij}); y_{ij}; (\tilde{z}_{ij}, z_{ij})\right]\right]$, as indicated in Table 2. If there are k experts in the expert group, the responses must be calculated in $s'_{ij} = \frac{1}{k}\left(s'^{1}_{ij} + s'^{2}_{ij} + s'^{3}_{ij} + \cdots s'^{k}_{ij}\right) = \frac{1}{k}\sum_{1}^{k} s'^{n}_{ij}$. In addition, the responses must normalize into performance rating matrix $S^* = [s^*_{ij}]_{m \times n}$ as below:

$$[s^B_{ij}]_{m \times n} = \left[\left(\frac{x_{ij}}{z_j^+}, \frac{\tilde{x}_{ij}}{z_j^+}\right); \frac{y_{ij}}{z_j^+}; \left(\frac{\tilde{z}_{ij}}{z_j^+}, \frac{z_{ij}}{z_j^+}\right)\right]_{m \times n}, i = 1,2, \cdots, m; j = 1,2, \cdots, n, for\ j \in B \quad (1)$$

$$[s^C_{ij}]_{m \times n} = \left[\left(\frac{x_j^-}{z_{ij}}, \frac{x_j^-}{\tilde{z}_{ij}}\right); \frac{x_j^-}{y_{ij}}; \left(\frac{x_j^-}{\tilde{x}_{ij}}, \frac{x_j^-}{x_{ij}}\right)\right]_{m \times n}, i = 1,2, \cdots, m; j = 1,2, \cdots, n, for\ j \in C \quad (2)$$

where $z_j^+ = max_i\{z_{ij}, i = 1 \cdots m\}, x_j^- = min_i\{x_{ij}, i = 1 \cdots m\}$, and B and C are the sets of benefit and cost criteria.

Table 2. Definitions of linguistic variables for the importance ratings.

Linguistic Variables	Interval-Valued TFNs
Very unimportant (VU)	$[(0,0); 0; (0.1, 0.15)]$
Unimportant (U)	$[(0,0.05); 0.1; (0.25,0.35)]$
Medium unimportant (MU)	$[(0,0.15); 0.3; (0.45,0.55)]$
Medium (M)	$[(0.25,0.35); 0.5; (0.65,0.75)]$
Medium important (MI)	$[(0.45,0.55); 0.7; (0.8,0.95)]$
Important (I)	$[(0.55,0.75); 0.9; (0.95,1)]$
Very important (VI)	$[(0.85,0.95); 1; (1,1)]$

Second, determine the reference series $R_0 = (r_{01}, r_{02}, \cdots, r_{0n})$, which is supposed to be 1 as in the case of the reference value in the decision-making problem. Hence, the reference series can be rewritten as $R_0 = ([(1,1); 1; (1,1)], [(1,1); 1; (1,1)], \cdots, [(1,1); 1; (1,1)])$. Once the reference series is obtained, the following computation must identify the gap between the reference value and each comparison value. The computation can use the following equations:

$$\begin{cases} \vartheta_{ij}^{(B)} = \sqrt{\frac{1}{3}\left[\left(\frac{\tilde{x}_{ij}}{z_j^+} - 1\right)^2 + \left(\frac{y_{ij}}{z_j^+}\right)^2 + \left(\frac{z_{ij}}{z_j^+} - 1\right)^2\right]}, \\ \vartheta_{ij}^{(\bar{B})} = \sqrt{\frac{1}{3}\left[\left(\frac{x_{ij}}{z_j^+} - 1\right)^2 + \left(\frac{y_{ij}}{z_j^+}\right)^2 + \left(\frac{\tilde{z}_{ij}}{z_j^+} - 1\right)^2\right]}, \\ \vartheta_{ij}^{(C)} = \sqrt{\frac{1}{3}\left[\left(\frac{x_j^-}{\tilde{z}_{ij}} - 1\right)^2 + \left(\frac{x_j^-}{y_{ij}}\right)^2 + \left(\frac{x_j^-}{x_{ij}} - 1\right)^2\right]}, \\ \vartheta_{ij}^{(\bar{C})} = \sqrt{\frac{1}{3}\left[\left(\frac{x_j^-}{z_{ij}} - 1\right)^2 + \left(\frac{x_j^-}{y_{ij}}\right)^2 + \left(\frac{x_j^-}{\tilde{x}_{ij}} - 1\right)^2\right]} \end{cases} \quad (3)$$

The gap can be simplified as an interval value $\vartheta_{ij}^* = \left[\hat{\vartheta}_{ij}, \check{\vartheta}_{ij}\right]$, where $\hat{\vartheta}_{ij} = \vartheta_{ij}^{(B)} - \vartheta_{ij}^{(\bar{B})}$ and $\check{\vartheta}_{ij} = \vartheta_{ij}^{(C)} - \vartheta_{ij}^{(\bar{C})}$. Because some information is lost during the computation process, the interval value must convert into a crisp value immediately. Simultaneously, the maximum $[\rho', \gamma']$ and minimum $[\rho^-, \gamma^-]$ can be gathered from the crisp value, as below:

$$\begin{cases} [\rho', \gamma'] = \left[max_{ij}\hat{\vartheta}_{ij}, max_{ij}\check{\vartheta}_{ij}\right] \\ [\rho^-, \gamma^-] = \left[min_{ij}\hat{\vartheta}_{ij}, min_{ij}\check{\vartheta}_{ij}\right] \end{cases}, i = 1,2,\cdots,m; j = 1,2,\cdots,n \quad (4)$$

Third, assuming τ is 0.5 and using the following equations to generate the grey relational coefficient:

$$\begin{cases} \varepsilon'_{ij} = \rho^- + \tau\rho'/\hat{\vartheta}_{ij} + \tau\rho' \\ \varepsilon^*_{ij} = \gamma^- + \tau\gamma'/\check{\vartheta}_{ij} + \tau\gamma' \end{cases}, i = 1,2,\cdots,m; j = 1,2,\cdots,n \quad (5)$$

To obtain the grey relational grade, Zhang *et al.* [76] suggested normalizing the data by adopting weightage vector v_j:

$$v_j = \sum_{i=1}^{m}\left(\varepsilon'_{ij} + \varepsilon^*_{ij}\right) \Big/ \sum_{i=1}^{m}\sum_{j=1}^{n}\left(\varepsilon'_{ij} + \varepsilon^*_{ij}\right), j = 1,2,\cdots,n \quad (6)$$

When the weightage vector $v = (v_1, v_2, \cdots v_n)$ is attained, the grey relational grade can be expressed as an interval value $D_i = [\bar{d}_i, \tilde{d}_i]$:

$$\bar{d}_i = \sum_{j=1}^{n} v_j \varepsilon'_{ij}, \tilde{d}_i = \sum_{j=1}^{n} v_j \varepsilon^*_{ij}, i = 1,2 \cdots, m \tag{7}$$

Therefore, the grey relational grade must comply with the likelihood properties to transfer the interval value to a likelihood matrix. Li *et al.* [77] presented the following helpful likelihood properties:

$$\begin{cases} 0 \le \mu(x \ge y) \le 1; \\ \mu(x \ge y) + \mu(y \ge x) = 1; \\ \mu(x \ge y) + \mu(y \ge x) = 0.5 \; if \; \mu(x \ge y) = \mu(y \ge x); \\ \mu(x \ge y) = 0 \; if \; x^+ \le y^-; \\ For \; any \; interval \; numbers \; x, y \; and \; z, \mu(x \ge z) = \mu(y \ge z) \; if \; x \ge y \end{cases} \tag{8}$$

Finally, transform the grey relational grade into likelihood relations. The likelihood relation can be denoted as $\alpha_o \succcurlyeq \alpha_p$, which means "criteria α_o being not inferior to α_p". Li *et al.* [77] indicated that the likelihood relation of $\alpha_o \succcurlyeq \alpha_p$ is evaluated by $G_o \succcurlyeq G_p$, where G_o and G_p are corresponding grey relational grade interval numbers of criteria α_o and α_p in α. The transforming process applies the equation as below:

$$\rho(\alpha_o \succcurlyeq \alpha_p) = \rho(D_o \succcurlyeq D_p) = \max\left\{1 - \max\left\{(\tilde{d}_p - \bar{d}_o)/\left(\varphi(D_o) + \varphi(D_p)\right), 0\right\}, 0\right\} \tag{9}$$

where $D_o = [\bar{d}_o, \tilde{d}_o], D_p = [\bar{d}_p, \tilde{d}_p], \varphi(D_o) = \tilde{d}_o - \bar{d}_o, \varphi(D_p) = \tilde{d}_p - \bar{d}_p$.

The likelihood relations can be arranged into the likelihood matrix as $\tilde{S}$:

$$\tilde{S} = (\rho_{op})_{m \times m} = \begin{array}{c} \\ \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_m \end{array} \begin{array}{c} \begin{array}{cccc} \alpha_1 & \alpha_2 & \cdots & \alpha_m \end{array} \\ \begin{pmatrix} \rho_{11} & \rho_{12} & \cdots & \rho_{1m} \\ \rho_{21} & \rho_{22} & \cdots & \rho_{2m} \\ \vdots & \vdots & & \vdots \\ \rho_{m1} & \rho_{m1} & \cdots & \rho_{mm} \end{pmatrix} \end{array} \tag{10}$$

where $\rho_{op} = \rho(\alpha_o \succcurlyeq \alpha_p) \; (o, p = 1,2, \cdots, m)$ for criteria α_o and α_p. Consequently, the $\tilde{S}$ is a complementary judgment matrix, and the ranking weightage can be sorted from the eigenvector E_i $(i = 1,2, \cdots m)$. The larger value of E_i represents the greater importance of criteria α_i $(i = 1,2, \cdots m)$ [76].

3.2. Proposed Analytical Step

This study adopts IVTFN and GRA to evaluate five aspects and 30 criteria. The objective is to determine the priority ranking in innovation for SBMCC. The expert group followed the proposed solution with a four-step procedure. The analysis procedures are explained as follows:

(1) Identification of the evaluating aspects and criteria. This step collects group knowledge and experiences from the expert committee to evaluate the importance of SBMCC. The committee develops the aspects and criteria—and the survey instruments—to establish a set of aspects and criteria for evaluation. The cluster of aspects and criteria has the nature of complicated relationships.

(2) Computation of the range between the experts' decisions related to each criterion. In the beginning of this step, this study used interval-valued triangular fuzzy numbers (as indicated in Table 2) to normalize the decision matrix into an important rating. If the expert committee has different opinions about the decision, the average scores can eliminate the situation. Benefit and cost can be found by following Equations (1) and (2). Next, calculating the distance is required to contract with the reference value and transfer to the interval value by Equation (3). However, some information has been lost during the computation, so the interval values must be expressed as crisp values immediately, as in Equation (4).

(3) Once the crisp value is obtained, the grey relational coefficient must be generated by Equation (5). Before converting the grey relational coefficient to the grey relational grade, the weightage vector must be obtained through Equation (6) first and then Equation (7) is used to finish the transformation. Consequently, the grey relational grade must associate with likelihood properties as in Equation (8) to calculate the likelihood relations.

(4) Then, adopt Equation (9) to gather all likelihood relations and arrange them into a matrix by adopting Equation (10). The matrix is decomposed using MATLAB 10 to acquire the eigenvectors for each of the criteria. The largest eigenvector has the greatest effect on SBMCC.

4. Results

This section presents an overview of Taiwanese hotels and data collection methods and is divided into two subsections: industrial background and analytical results.

4.1. Industrial Background

The tourism industry continues to expand and diversify and has become one of the largest and fastest growing economic sectors in the world [78]. In Taiwan, the demand for recreational travel has increased rapidly as the number of foreign visitors has increased. The tourism industry not only brings in substantial foreign exchange income but also provides job opportunities. The Tourism Bureau of the Ministry of Transportation and Communications of Taiwan 2014 has announced new directions for the Taiwan tourism industry. Hopefully, the number of foreign tourists visiting Taiwan will continue to increase, thus benefiting the hotel industry. Additionally, several international hotel chains are racing to boost their presence in response to the booming tourism industry due to globalization. This intensifies the competition in the hospitality industries, particularly in hotel firms.

To assist firms in the hotel industry in this competitive environment and to guarantee sustainable growth, this study has been conducted to obtain a better understanding of the contribution of innovation to sustainable business, thus providing several managerial insights related to SBMCC. This study adopted GRA and IVTFN to evaluate the importance of certain aspects and criteria. Questionnaires were created based on interviews with executive management and industrial experts to collect the aspects and criteria. The analysis outlined in the following section describes the process followed by the hotels in Taiwan and the recommendations given to them.

4.2. The Empirical Results

Gathering the respondent opinions ensures that clear relationships are determined in the evaluation of aspects and criteria; it also confirms the information that is relevant to representing the SBMCC by consulting the expert committee. Each proposed aspect and criterion in Table 1 prompted several arguments and discussions among the members of the expert committee related to enhancing the study's validity and reliability. Once the experts raised an argument or debate, interviewing was adopted for further clarification. To overcome problematic linguistic preferences and complicated interactions in the respondent feedback, a hybrid method was designed integrating IVTFN and GRA.

(1) Table 3 presents the preference information of the experts' responses. The preference information must convert into IVTFNs based on Table 1; the average IVTFNs are displayed in Table 4. Tables 5 and 6 display the benefit and cost criteria matrices generated by Equations (1) and (2).

Table 3. Experts' responses.

	Expert 1					Expert 2					Expert 3					Expert 4					Expert 5					Expert 6					Expert 7				
	AS1	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**
C1	M	I	MI	M	MU	M	VI	MI	U	M	VU	I	MI	U	U	M	VI	MI	M	M	M	VI	I	M	M	U	I	I	U	U	I	VI	VI	MU	M
C2	MU	I	MI	MU	U	M	VI	MI	VU	U	M	VI	MI	M	M	VU	VI	I	I	M	M	I	I	U	VU	M	I	I	M	U	M	M	VI	U	U
C3	U	VI	I	MU	MU	U	I	VI	U	U	M	VI	I	M	M	M	VI	VI	M	M	U	I	VI	U	M	U	I	MI	M	M	U	VI	VI	MU	M
C4	U	I	I	VU	MU	U	I	I	MU	U	M	I	M	M	U	M	I	M	M	VU	M	I	M	M	M	M	MI	M	VU	VU	I	M	M	VU	VU
C5	U	I	VI	MU	M	M	I	I	M	MU	U	MI	MI	MU	M	M	VI	VI	M	I	U	VI	VI	U	U	U	I	VI	U	U	U	VI	VI	I	MU
C6	U	VI	VI	MU	MU	VU	VI	I	I	U	VU	VI	VI	U	MU	M	I	I	I	M	U	VI	VI	M	U	U	I	MI	M	M	MU	VI	VI	MU	M
C7	M	I	I	MU	U	U	I	I	VI	MU	VU	MI	I	MU	MU	M	VI	I	M	M	U	I	I	M	M	U	I	I	U	U	I	M	VI	MU	M
C8	U	VI	I	M	MU	VU	VI	VI	I	M	M	MI	MI	MU	M	M	I	VI	I	M	U	I	VI	M	U	U	I	I	M	U	U	VI	I	I	I
C9	I	VI	VI	I	I	I	VI	VI	I	I	I	VI	VI	I	I	I	VI	VI	MI	I	I	VI	VI	I	I	I	VI	VI	I	I	I	VI	VI	I	I
C10	MU	VI	I	U	VU	M	I	M	VU	M	VU	I	MI	MU	U	M	I	I	I	M	M	I	I	M	U	U	I	I	U	U	I	VI	I	M	MU
C11	U	VI	I	U	U	VU	VI	VI	U	U	VU	MI	MI	MU	M	M	I	VI	M	M	U	VI	VI	M	M	U	I	I	M	U	U	VI	MI	MU	I
C12	M	I	I	U	M	VU	VI	VI	MU	MU	M	VI	VI	MU	M	M	I	I	M	I	U	I	I	U	U	U	MI	MI	M	M	U	VI	VI	I	M
C13	MU	VI	VI	M	U	VU	VI	VI	M	U	VU	MI	I	M	MU	M	I	I	I	I	M	VI	VI	U	U	U	VI	I	U	U	U	VI	VI	MU	M
C14	MI	VI	I	I	I	M	VI	I	I	MI	U	VI	MI	MI	MI	MI	VI	I	I	MI	I	VI	I	MI	MI	I	VI	I	MI	MI	I	VI	I	MI	MI
C15	U	I	I	U	M	U	VI	MI	MU	M	VU	I	VI	U	MU	M	I	VI	M	M	M	VI	I	U	M	U	I	MI	M	M	U	I	M	I	MU

Table 3. *Cont.*

	Expert 1					Expert 2					Expert 3					Expert 4					Expert 5					Expert 6					Expert 7				
	AS1	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**	**AS1**	**AS2**	**AS3**	**AS4**	**AS5**
C16	U	I	VI	M	MU	U	I	I	MU	M	VU	I	M	MU	MU	U	I	VI	M	I	M	VI	I	M	U	U	I	MI	M	U	U	I	I	I	MU
C17	M	VI	I	M	M	M	I	I	M	MU	M	M	M	MU	U	M	I	I	M	M	M	I	I	U	M	U	I	I	U	U	I	I	M	M	M
C18	MU	I	VI	M	MU	M	I	I	MU	MU	VU	M	M	M	MU	U	I	I	M	VI	U	VI	I	M	U	U	I	I	M	U	I	VI	I	I	MU
C19	M	I	VI	MU	U	VU	VI	VI	U	MU	VU	I	VI	MU	M	M	I	I	I	M	U	I	I	M	M	U	MI	I	U	U	I	I	M	MU	MU
C20	M	VI	VI	M	M	VU	VI	I	MU	MU	VU	I	VI	MU	MU	U	VI	I	I	M	U	I	VI	U	U	U	I	I	U	M	I	I	M	MU	M
C21	MU	I	VI	U	MU	VU	VI	MI	MU	U	U	VI	VI	MU	MU	M	VI	VI	M	M	U	VI	I	U	M	U	VI	MI	U	U	MU	I	VI	I	I
C22	I	M	MI	MU	MU	I	I	M	MU	MU	I	I	M	MU	MU	I	I	MI	MU	MU	MI	I	MI	MU	MU	I	I	M	MU	MU	M	I	M	M	I
C23	M	VI	I	M	MU	VU	VI	I	MU	M	U	VI	I	U	M	M	I	I	M	M	M	VI	I	M	U	U	I	I	U	U	I	M	I	I	MU
C24	MU	I	MU	MU	MU	M	VI	M	MU	U	U	VI	M	M	MU	U	I	M	M	I	U	I	M	U	M	U	I	I	M	M	I	I	I	I	MU
C25	MU	I	I	U	M	M	I	VI	U	M	VU	I	M	M	M	M	I	I	M	I	U	I	I	M	U	U	I	I	U	U	I	I	M	I	I
C26	U	I	M	M	MU	M	VI	I	MU	M	M	I	MI	M	MU	M	I	M	I	M	M	VI	MI	VU	U	U	I	MI	VU	U	I	I	M	M	M
C27	MU	I	I	MU	MU	M	I	MI	MU	MU	M	M	VI	MU	U	M	I	I	M	I	M	VI	VI	U	U	U	VI	I	MU	M	U	I	I	M	MU
C28	U	I	VI	M	U	U	VI	I	U	MU	M	M	M	M	M	M	VI	VI	I	I	M	VI	VI	M	U	U	MI	MI	U	MU	U	I	I	MU	I
C29	U	VI	I	U	MU	U	VI	I	U	M	VU	I	M	U	MU	M	I	I	M	M	M	VI	VI	M	M	U	MI	MI	M	U	I	I	I	MU	MU
C30	M	I	VI	M	U	VU	VI	MI	U	MU	U	M	M	M	U	M	VI	I	M	M	M	I	VI	U	M	U	I	I	M	MU	MU	M	I	M	I

Table 4. Converting interval-valued triangular fuzzy numbers from expert responses.

	AS1					AS2					AS3				
	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}
C1	0.2214	0.3143	0.4286	0.5571	0.6429	0.7214	0.8643	0.9571	0.9786	1.0000	0.5357	0.6643	0.8000	0.8714	0.9714
C2	0.1786	0.2714	0.4000	0.5429	0.6357	0.6357	0.7786	0.8857	0.9286	0.9643	0.5500	0.6929	0.8286	0.8929	0.9786
C3	0.0714	0.1357	0.2143	0.3643	0.4643	0.7214	0.8643	0.9571	0.9786	1.0000	0.7071	0.8357	0.9286	0.9571	0.9929
C4	0.2214	0.3214	0.4429	0.5786	0.6714	0.4929	0.6643	0.8143	0.8857	0.9571	0.3357	0.4643	0.6143	0.7357	0.8214
C5	0.0714	0.1357	0.2143	0.3643	0.4643	0.6643	0.8071	0.9143	0.9500	0.9929	0.7500	0.8643	0.9429	0.9643	0.9929
C6	0.0357	0.0929	0.1571	0.2929	0.3786	0.7643	0.8929	0.9714	0.9857	1.0000	0.7071	0.8357	0.9286	0.9571	0.9929
C7	0.1500	0.2286	0.3143	0.4429	0.5286	0.5357	0.6929	0.8286	0.8929	0.9571	0.5929	0.7786	0.9143	0.9571	1.0000
C8	0.0714	0.1286	0.2000	0.3429	0.4357	0.6643	0.8071	0.9143	0.9500	0.9929	0.6643	0.8071	0.9143	0.9500	0.9929
C9	0.5500	0.7500	0.9000	0.9500	1.0000	0.8500	0.9500	1.0000	1.0000	1.0000	0.8500	0.9500	1.0000	1.0000	1.0000
C10	0.1857	0.2857	0.4000	0.5286	0.6143	0.6357	0.8071	0.9286	0.9643	1.0000	0.4929	0.6643	0.8143	0.8857	0.9571
C11	0.0357	0.0786	0.1286	0.2643	0.3500	0.7071	0.8357	0.9286	0.9571	0.9929	0.6500	0.7786	0.8857	0.9286	0.9857
C12	0.1071	0.1714	0.2571	0.4000	0.4929	0.6643	0.8071	0.9143	0.9500	0.9929	0.6643	0.8071	0.9143	0.9500	0.9929
C13	0.0714	0.1357	0.2143	0.3500	0.4357	0.7500	0.8643	0.9429	0.9643	0.9929	0.7214	0.8643	0.9571	0.9786	1.0000
C14	0.4000	0.5357	0.6714	0.7643	0.8571	0.8500	0.9500	1.0000	1.0000	1.0000	0.5357	0.7214	0.8714	0.9286	0.9929
C15	0.0714	0.1286	0.2000	0.3429	0.4357	0.6357	0.8071	0.9286	0.9643	1.0000	0.5643	0.6929	0.8143	0.8786	0.9500
C16	0.0357	0.0857	0.1429	0.2857	0.3786	0.5929	0.7786	0.9143	0.9571	1.0000	0.5786	0.7214	0.8429	0.9000	0.9571
C17	0.2571	0.3643	0.5000	0.6357	0.7286	0.5500	0.7214	0.8571	0.9143	0.9643	0.4643	0.6357	0.7857	0.8643	0.9286
C18	0.1143	0.2000	0.2857	0.4143	0.5000	0.5929	0.7500	0.8714	0.9214	0.9643	0.5500	0.7214	0.8571	0.9143	0.9643
C19	0.1500	0.2214	0.3000	0.4214	0.5000	0.5786	0.7500	0.8857	0.9357	0.9929	0.6357	0.7786	0.8857	0.9286	0.9643
C20	0.1143	0.1786	0.2429	0.3643	0.4429	0.6786	0.8357	0.9429	0.9714	1.0000	0.6357	0.7786	0.8857	0.9286	0.9643
C21	0.0357	0.1143	0.2000	0.3429	0.4357	0.7643	0.8929	0.9714	0.9857	1.0000	0.6929	0.8071	0.9000	0.9357	0.9857
C22	0.4929	0.6643	0.8143	0.8857	0.9571	0.5071	0.6929	0.8429	0.9071	0.9643	0.3357	0.4357	0.5857	0.7143	0.8357
C23	0.1857	0.2714	0.3714	0.5000	0.5857	0.6786	0.8071	0.9000	0.9357	0.9643	0.5500	0.7500	0.9000	0.9500	1.0000
C24	0.1143	0.2071	0.3000	0.4357	0.5286	0.6357	0.8071	0.9286	0.9643	1.0000	0.3000	0.4357	0.5857	0.7071	0.7929
C25	0.1500	0.2429	0.3429	0.4714	0.5571	0.5500	0.7500	0.9000	0.9500	1.0000	0.5071	0.6643	0.8000	0.8714	0.9286
C26	0.2214	0.3214	0.4429	0.5786	0.6714	0.6357	0.8071	0.9286	0.9643	1.0000	0.3786	0.4929	0.6429	0.7571	0.8714
C27	0.1429	0.2357	0.3571	0.5071	0.6071	0.5929	0.7500	0.8714	0.9214	0.9643	0.6214	0.7786	0.9000	0.9429	0.9929
C28	0.1071	0.1786	0.2714	0.4214	0.5214	0.6214	0.7500	0.8571	0.9071	0.9571	0.6214	0.7500	0.8571	0.9071	0.9571
C29	0.1500	0.2286	0.3143	0.4429	0.5286	0.6643	0.8071	0.9143	0.9500	0.9929	0.5357	0.6929	0.8286	0.8929	0.9571
C30	0.1071	0.1857	0.2857	0.4286	0.5214	0.5500	0.6929	0.8143	0.8786	0.9286	0.5786	0.7214	0.8429	0.9000	0.9571

Table 4. *Cont.*

	AS4					AS5				
	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}
C1	0.1071	0.1929	0.3000	0.4500	0.5500	0.1429	0.2357	0.3571	0.5071	0.6071
C2	0.1500	0.2429	0.3429	0.4714	0.5571	0.0714	0.1286	0.2000	0.3429	0.4357
C3	0.1071	0.2071	0.3286	0.4786	0.5786	0.1786	0.2786	0.4143	0.5643	0.6643
C4	0.1071	0.1714	0.2571	0.3857	0.4643	0.0357	0.0857	0.1429	0.2714	0.3500
C5	0.1500	0.2643	0.3857	0.5214	0.6143	0.1500	0.2643	0.3857	0.5214	0.6143
C6	0.2286	0.3643	0.5000	0.6214	0.7071	0.1071	0.2071	0.3286	0.4786	0.5786
C7	0.1929	0.3071	0.4286	0.5571	0.6429	0.1071	0.2071	0.3286	0.4786	0.5786
C8	0.3429	0.4929	0.6429	0.7500	0.8286	0.1857	0.2929	0.4143	0.5500	0.6429
C9	0.5357	0.7214	0.8714	0.9286	0.9929	0.5500	0.7500	0.9000	0.9500	1.0000
C10	0.1500	0.2429	0.3429	0.4714	0.5571	0.0714	0.1429	0.2286	0.3714	0.4643
C11	0.1071	0.2071	0.3286	0.4786	0.5786	0.1857	0.2786	0.3857	0.5214	0.6143
C12	0.1500	0.2643	0.3857	0.5214	0.6143	0.2214	0.3357	0.4714	0.6071	0.7000
C13	0.1857	0.2929	0.4143	0.5500	0.6429	0.1143	0.2071	0.3000	0.4357	0.5286
C14	0.4929	0.6357	0.7857	0.8643	0.9714	0.4643	0.5786	0.7286	0.8214	0.9571
C15	0.1500	0.2500	0.3571	0.4929	0.5857	0.1786	0.2929	0.4429	0.5929	0.6929
C16	0.2214	0.3500	0.5000	0.6357	0.7286	0.1143	0.2357	0.3571	0.4929	0.5857
C17	0.1429	0.2357	0.3571	0.5071	0.6071	0.1429	0.2357	0.3571	0.5071	0.6071
C18	0.2571	0.3786	0.5286	0.6643	0.7571	0.1214	0.2357	0.3429	0.4714	0.5571
C19	0.1143	0.2357	0.3571	0.4929	0.5857	0.1071	0.2071	0.3286	0.4786	0.5786
C20	0.1143	0.2357	0.3571	0.4929	0.5857	0.1429	0.2500	0.3857	0.5357	0.6357
C21	0.1143	0.2214	0.3286	0.4643	0.5571	0.1500	0.2643	0.3857	0.5214	0.6143
C22	0.0357	0.1786	0.3286	0.4786	0.5786	0.0786	0.2357	0.3857	0.5214	0.6143
C23	0.1857	0.2929	0.4143	0.5500	0.6429	0.1071	0.2071	0.3286	0.4786	0.5786
C24	0.1857	0.3071	0.4429	0.5786	0.6714	0.1500	0.2786	0.4143	0.5500	0.6429
C25	0.1857	0.2786	0.3857	0.5214	0.6143	0.2643	0.3786	0.5000	0.6214	0.7071
C26	0.1857	0.2786	0.3857	0.5071	0.5857	0.1071	0.2071	0.3286	0.4786	0.5786
C27	0.0714	0.1929	0.3286	0.4786	0.5786	0.1143	0.2357	0.3571	0.4929	0.5857
C28	0.1857	0.2929	0.4143	0.5500	0.6429	0.1929	0.3214	0.4429	0.5643	0.6500
C29	0.1071	0.1929	0.3000	0.4500	0.5500	0.1071	0.2214	0.3571	0.5071	0.6071
C30	0.1786	0.2643	0.3857	0.5357	0.6357	0.1500	0.2643	0.3857	0.5214	0.6143

Table 5. Benefit matrix.

	AS1					AS2					AS3				
	x_{ij}	$\widetilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\widetilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\widetilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}
C1	0.2214	0.3143	0.4286	0.5571	0.6429	0.7214	0.8643	0.9571	0.9786	1.0000	0.5357	0.6643	0.8000	0.8714	0.9714
C2	0.1786	0.2714	0.4000	0.5429	0.6357	0.6357	0.7786	0.8857	0.9286	0.9643	0.5500	0.6929	0.8286	0.8929	0.9786
C3	0.0714	0.1357	0.2143	0.3643	0.4643	0.7214	0.8643	0.9571	0.9786	1.0000	0.7071	0.8357	0.9286	0.9571	0.9929
C4	0.2214	0.3214	0.4429	0.5786	0.6714	0.4929	0.6643	0.8143	0.8857	0.9571	0.3357	0.4643	0.6143	0.7357	0.8214
C5	0.0714	0.1357	0.2143	0.3643	0.4643	0.6643	0.8071	0.9143	0.9500	0.9929	0.7500	0.8643	0.9429	0.9643	0.9929
C6	0.0357	0.0929	0.1571	0.2929	0.3786	0.7643	0.8929	0.9714	0.9857	1.0000	0.7071	0.8357	0.9286	0.9571	0.9929
C7	0.1500	0.2286	0.3143	0.4429	0.5286	0.5357	0.6929	0.8286	0.8929	0.9571	0.5929	0.7786	0.9143	0.9571	1.0000
C8	0.0714	0.1286	0.2000	0.3429	0.4357	0.6643	0.8071	0.9143	0.9500	0.9929	0.6643	0.8071	0.9143	0.9500	0.9929
C9	0.5500	0.7500	0.9000	0.9500	1.0000	0.8500	0.9500	1.0000	1.0000	1.0000	0.8500	0.9500	1.0000	1.0000	1.0000
C10	0.1857	0.2857	0.4000	0.5286	0.6143	0.6357	0.8071	0.9286	0.9643	1.0000	0.4929	0.6643	0.8143	0.8857	0.9571
C11	0.0357	0.0786	0.1286	0.2643	0.3500	0.7071	0.8357	0.9286	0.9571	0.9929	0.6500	0.7786	0.8857	0.9286	0.9857
C12	0.1071	0.1714	0.2571	0.4000	0.4929	0.6643	0.8071	0.9143	0.9500	0.9929	0.6643	0.8071	0.9143	0.9500	0.9929
C13	0.0714	0.1357	0.2143	0.3500	0.4357	0.7500	0.8643	0.9429	0.9643	0.9929	0.7214	0.8643	0.9571	0.9786	1.0000
C14	0.4000	0.5357	0.6714	0.7643	0.8571	0.8500	0.9500	1.0000	1.0000	1.0000	0.5357	0.7214	0.8714	0.9286	0.9929
C15	0.0714	0.1286	0.2000	0.3429	0.4357	0.6357	0.8071	0.9286	0.9643	1.0000	0.5643	0.6929	0.8143	0.8786	0.9500
C16	0.0357	0.0857	0.1429	0.2857	0.3786	0.5929	0.7786	0.9143	0.9571	1.0000	0.5786	0.7214	0.8429	0.9000	0.9571
C17	0.2571	0.3643	0.5000	0.6357	0.7286	0.5500	0.7214	0.8571	0.9143	0.9643	0.4643	0.6357	0.7857	0.8643	0.9286
C18	0.1143	0.2000	0.2857	0.4143	0.5000	0.5929	0.7500	0.8714	0.9214	0.9643	0.5500	0.7214	0.8571	0.9143	0.9643
C19	0.1500	0.2214	0.3000	0.4214	0.5000	0.5786	0.7500	0.8857	0.9357	0.9929	0.6357	0.7786	0.8857	0.9286	0.9643
C20	0.1143	0.1786	0.2429	0.3643	0.4429	0.6786	0.8357	0.9429	0.9714	1.0000	0.6357	0.7786	0.8857	0.9286	0.9643
C21	0.0357	0.1143	0.2000	0.3429	0.4357	0.7643	0.8929	0.9714	0.9857	1.0000	0.6929	0.8071	0.9000	0.9357	0.9857
C22	0.4929	0.6643	0.8143	0.8857	0.9571	0.5071	0.6929	0.8429	0.9071	0.9643	0.3357	0.4357	0.5857	0.7143	0.8357
C23	0.1857	0.2714	0.3714	0.5000	0.5857	0.6786	0.8071	0.9000	0.9357	0.9643	0.5500	0.7500	0.9000	0.9500	1.0000
C24	0.1143	0.2071	0.3000	0.4357	0.5286	0.6357	0.8071	0.9286	0.9643	1.0000	0.3000	0.4357	0.5857	0.7071	0.7929
C25	0.1500	0.2429	0.3429	0.4714	0.5571	0.5500	0.7500	0.9000	0.9500	1.0000	0.5071	0.6643	0.8000	0.8714	0.9286
C26	0.2214	0.3214	0.4429	0.5786	0.6714	0.6357	0.8071	0.9286	0.9643	1.0000	0.3786	0.4929	0.6429	0.7571	0.8714
C27	0.1429	0.2357	0.3571	0.5071	0.6071	0.5929	0.7500	0.8714	0.9214	0.9643	0.6214	0.7786	0.9000	0.9429	0.9929
C28	0.1071	0.1786	0.2714	0.4214	0.5214	0.6214	0.7500	0.8571	0.9071	0.9571	0.6214	0.7500	0.8571	0.9071	0.9571
C29	0.1500	0.2286	0.3143	0.4429	0.5286	0.6643	0.8071	0.9143	0.9500	0.9929	0.5357	0.6929	0.8286	0.8929	0.9571
C30	0.1071	0.1857	0.2857	0.4286	0.5214	0.5500	0.6929	0.8143	0.8786	0.9286	0.5786	0.7214	0.8429	0.9000	0.9571

Table 5. *Cont.*

	AS4					AS5				
	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}
C1	0.1071	0.1929	0.3000	0.4500	0.5500	0.1429	0.2357	0.3571	0.5071	0.6071
C2	0.1500	0.2429	0.3429	0.4714	0.5571	0.0714	0.1286	0.2000	0.3429	0.4357
C3	0.1071	0.2071	0.3286	0.4786	0.5786	0.1786	0.2786	0.4143	0.5643	0.6643
C4	0.1071	0.1714	0.2571	0.3857	0.4643	0.0357	0.0857	0.1429	0.2714	0.3500
C5	0.1500	0.2643	0.3857	0.5214	0.6143	0.1500	0.2643	0.3857	0.5214	0.6143
C6	0.2286	0.3643	0.5000	0.6214	0.7071	0.1071	0.2071	0.3286	0.4786	0.5786
C7	0.1929	0.3071	0.4286	0.5571	0.6429	0.1071	0.2071	0.3286	0.4786	0.5786
C8	0.3429	0.4929	0.6429	0.7500	0.8286	0.1857	0.2929	0.4143	0.5500	0.6429
C9	0.5357	0.7214	0.8714	0.9286	0.9929	0.5500	0.7500	0.9000	0.9500	1.0000
C10	0.1500	0.2429	0.3429	0.4714	0.5571	0.0714	0.1429	0.2286	0.3714	0.4643
C11	0.1071	0.2071	0.3286	0.4786	0.5786	0.1857	0.2786	0.3857	0.5214	0.6143
C12	0.1500	0.2643	0.3857	0.5214	0.6143	0.2214	0.3357	0.4714	0.6071	0.7000
C13	0.1857	0.2929	0.4143	0.5500	0.6429	0.1143	0.2071	0.3000	0.4357	0.5286
C14	0.4929	0.6357	0.7857	0.8643	0.9714	0.4643	0.5786	0.7286	0.8214	0.9571
C15	0.1500	0.2500	0.3571	0.4929	0.5857	0.1786	0.2929	0.4429	0.5929	0.6929
C16	0.2214	0.3500	0.5000	0.6357	0.7286	0.1143	0.2357	0.3571	0.4929	0.5857
C17	0.1429	0.2357	0.3571	0.5071	0.6071	0.1429	0.2357	0.3571	0.5071	0.6071
C18	0.2571	0.3786	0.5286	0.6643	0.7571	0.1214	0.2357	0.3429	0.4714	0.5571
C19	0.1143	0.2357	0.3571	0.4929	0.5857	0.1071	0.2071	0.3286	0.4786	0.5786
C20	0.1143	0.2357	0.3571	0.4929	0.5857	0.1429	0.2500	0.3857	0.5357	0.6357
C21	0.1143	0.2214	0.3286	0.4643	0.5571	0.1500	0.2643	0.3857	0.5214	0.6143
C22	0.0357	0.1786	0.3286	0.4786	0.5786	0.0786	0.2357	0.3857	0.5214	0.6143
C23	0.1857	0.2929	0.4143	0.5500	0.6429	0.1071	0.2071	0.3286	0.4786	0.5786
C24	0.1857	0.3071	0.4429	0.5786	0.6714	0.1500	0.2786	0.4143	0.5500	0.6429
C25	0.1857	0.2786	0.3857	0.5214	0.6143	0.2643	0.3786	0.5000	0.6214	0.7071
C26	0.1857	0.2786	0.3857	0.5071	0.5857	0.1071	0.2071	0.3286	0.4786	0.5786
C27	0.0714	0.1929	0.3286	0.4786	0.5786	0.1143	0.2357	0.3571	0.4929	0.5857
C28	0.1857	0.2929	0.4143	0.5500	0.6429	0.1929	0.3214	0.4429	0.5643	0.6500
C29	0.1071	0.1929	0.3000	0.4500	0.5500	0.1071	0.2214	0.3571	0.5071	0.6071
C30	0.1786	0.2643	0.3857	0.5357	0.6357	0.1500	0.2643	0.3857	0.5214	0.6143

Table 6. Cost matrix.

	AS1					AS2					AS3				
	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}	x_{ij}	$\tilde{x}_{ij}$	y_{ij}	$\tilde{z}_{ij}$	z_{ij}
C1	0.1613	0.1136	0.0833	0.0641	0.0556	0.0495	0.0413	0.0373	0.0365	0.0357	0.0667	0.0538	0.0446	0.0410	0.0368
C2	0.2000	0.1316	0.0893	0.0658	0.0562	0.0562	0.0459	0.0403	0.0385	0.0370	0.0649	0.0515	0.0431	0.0400	0.0365
C3	0.5000	0.2632	0.1667	0.0980	0.0769	0.0495	0.0413	0.0373	0.0365	0.0357	0.0505	0.0427	0.0385	0.0373	0.0360
C4	0.1613	0.1111	0.0806	0.0617	0.0532	0.0725	0.0538	0.0439	0.0403	0.0373	0.1064	0.0769	0.0581	0.0485	0.0435
C5	0.5000	0.2632	0.1667	0.0980	0.0769	0.0538	0.0442	0.0391	0.0376	0.0360	0.0476	0.0413	0.0379	0.0370	0.0360
C6	1.0000	0.3846	0.2273	0.1220	0.0943	0.0467	0.0400	0.0368	0.0362	0.0357	0.0505	0.0427	0.0385	0.0373	0.0360
C7	0.2381	0.1563	0.1136	0.0806	0.0676	0.0667	0.0515	0.0431	0.0400	0.0373	0.0602	0.0459	0.0391	0.0373	0.0357
C8	0.5000	0.2778	0.1786	0.1042	0.0820	0.0538	0.0442	0.0391	0.0376	0.0360	0.0538	0.0442	0.0391	0.0376	0.0360
C9	0.0649	0.0476	0.0397	0.0376	0.0357	0.0420	0.0376	0.0357	0.0357	0.0357	0.0420	0.0376	0.0357	0.0357	0.0357
C10	0.1923	0.1250	0.0893	0.0676	0.0581	0.0562	0.0442	0.0385	0.0370	0.0357	0.0725	0.0538	0.0439	0.0403	0.0373
C11	1.0000	0.4545	0.2778	0.1351	0.1020	0.0505	0.0427	0.0385	0.0373	0.0360	0.0549	0.0459	0.0403	0.0385	0.0362
C12	0.3333	0.2083	0.1389	0.0893	0.0725	0.0538	0.0442	0.0391	0.0376	0.0360	0.0538	0.0442	0.0391	0.0376	0.0360
C13	0.5000	0.2632	0.1667	0.1020	0.0820	0.0476	0.0413	0.0379	0.0370	0.0360	0.0495	0.0413	0.0373	0.0365	0.0357
C14	0.0893	0.0667	0.0532	0.0467	0.0417	0.0420	0.0376	0.0357	0.0357	0.0357	0.0667	0.0495	0.0410	0.0385	0.0360
C15	0.5000	0.2778	0.1786	0.1042	0.0820	0.0562	0.0442	0.0385	0.0370	0.0357	0.0633	0.0515	0.0439	0.0407	0.0376
C16	1.0000	0.4167	0.2500	0.1250	0.0943	0.0602	0.0459	0.0391	0.0373	0.0357	0.0617	0.0495	0.0424	0.0397	0.0373
C17	0.1389	0.0980	0.0714	0.0562	0.0490	0.0649	0.0495	0.0417	0.0391	0.0370	0.0769	0.0562	0.0455	0.0413	0.0385
C18	0.3125	0.1786	0.1250	0.0862	0.0714	0.0602	0.0476	0.0410	0.0388	0.0370	0.0649	0.0495	0.0417	0.0391	0.0370
C19	0.2381	0.1613	0.1190	0.0847	0.0714	0.0617	0.0476	0.0403	0.0382	0.0360	0.0562	0.0459	0.0403	0.0385	0.0370
C20	0.3125	0.2000	0.1471	0.0980	0.0806	0.0526	0.0427	0.0379	0.0368	0.0357	0.0562	0.0459	0.0403	0.0385	0.0370
C21	1.0000	0.3125	0.1786	0.1042	0.0820	0.0467	0.0400	0.0368	0.0362	0.0357	0.0515	0.0442	0.0397	0.0382	0.0362
C22	0.0725	0.0538	0.0439	0.0403	0.0373	0.0704	0.0515	0.0424	0.0394	0.0370	0.1064	0.0820	0.0610	0.0500	0.0427
C23	0.1923	0.1316	0.0962	0.0714	0.0610	0.0526	0.0442	0.0397	0.0382	0.0370	0.0649	0.0476	0.0397	0.0376	0.0357
C24	0.3125	0.1724	0.1190	0.0820	0.0676	0.0562	0.0442	0.0385	0.0370	0.0357	0.1190	0.0820	0.0610	0.0505	0.0450
C25	0.2381	0.1471	0.1042	0.0758	0.0641	0.0649	0.0476	0.0397	0.0376	0.0357	0.0704	0.0538	0.0446	0.0410	0.0385
C26	0.1613	0.1111	0.0806	0.0617	0.0532	0.0562	0.0442	0.0385	0.0370	0.0357	0.0943	0.0725	0.0556	0.0472	0.0410
C27	0.2500	0.1515	0.1000	0.0704	0.0588	0.0602	0.0476	0.0410	0.0388	0.0370	0.0575	0.0459	0.0397	0.0379	0.0360
C28	0.3333	0.2000	0.1316	0.0847	0.0685	0.0575	0.0476	0.0417	0.0394	0.0373	0.0575	0.0476	0.0417	0.0394	0.0373
C29	0.2381	0.1563	0.1136	0.0806	0.0676	0.0538	0.0442	0.0391	0.0376	0.0360	0.0667	0.0515	0.0431	0.0400	0.0373
C30	0.3333	0.1923	0.1250	0.0833	0.0685	0.0649	0.0515	0.0439	0.0407	0.0385	0.0617	0.0495	0.0424	0.0397	0.0373

Table 6. *Cont.*

	AS4					AS5				
	x_{ij}	$\widetilde{x}_{ij}$	y_{ij}	$\widetilde{z}_{ij}$	z_{ij}	x_{ij}	$\widetilde{x}_{ij}$	y_{ij}	$\widetilde{z}_{ij}$	z_{ij}
C1	0.3333	0.1852	0.1190	0.0794	0.0649	0.2500	0.1515	0.1000	0.0704	0.0588
C2	0.2381	0.1471	0.1042	0.0758	0.0641	0.5000	0.2778	0.1786	0.1042	0.0820
C3	0.3333	0.1724	0.1087	0.0746	0.0617	0.2000	0.1282	0.0862	0.0633	0.0538
C4	0.3333	0.2083	0.1389	0.0926	0.0769	1.0000	0.4167	0.2500	0.1316	0.1020
C5	0.2381	0.1351	0.0926	0.0685	0.0581	0.2381	0.1351	0.0926	0.0685	0.0581
C6	0.1563	0.0980	0.0714	0.0575	0.0505	0.3333	0.1724	0.1087	0.0746	0.0617
C7	0.1852	0.1163	0.0833	0.0641	0.0556	0.3333	0.1724	0.1087	0.0746	0.0617
C8	0.1042	0.0725	0.0556	0.0476	0.0431	0.1923	0.1220	0.0862	0.0649	0.0556
C9	0.0667	0.0495	0.0410	0.0385	0.0360	0.0649	0.0476	0.0397	0.0376	0.0357
C10	0.2381	0.1471	0.1042	0.0758	0.0641	0.5000	0.2500	0.1563	0.0962	0.0769
C11	0.3333	0.1724	0.1087	0.0746	0.0617	0.1923	0.1282	0.0926	0.0685	0.0581
C12	0.2381	0.1351	0.0926	0.0685	0.0581	0.1613	0.1064	0.0758	0.0588	0.0510
C13	0.1923	0.1220	0.0862	0.0649	0.0556	0.3125	0.1724	0.1190	0.0820	0.0676
C14	0.0725	0.0562	0.0455	0.0413	0.0368	0.0769	0.0617	0.0490	0.0435	0.0373
C15	0.2381	0.1429	0.1000	0.0725	0.0610	0.2000	0.1220	0.0806	0.0602	0.0515
C16	0.1613	0.1020	0.0714	0.0562	0.0490	0.3125	0.1515	0.1000	0.0725	0.0610
C17	0.2500	0.1515	0.1000	0.0704	0.0588	0.2500	0.1515	0.1000	0.0704	0.0588
C18	0.1389	0.0943	0.0676	0.0538	0.0472	0.2941	0.1515	0.1042	0.0758	0.0641
C19	0.3125	0.1515	0.1000	0.0725	0.0610	0.3333	0.1724	0.1087	0.0746	0.0617
C20	0.3125	0.1515	0.1000	0.0725	0.0610	0.2500	0.1429	0.0926	0.0667	0.0562
C21	0.3125	0.1613	0.1087	0.0769	0.0641	0.2381	0.1351	0.0926	0.0685	0.0581
C22	1.0000	0.2000	0.1087	0.0746	0.0617	0.4545	0.1515	0.0926	0.0685	0.0581
C23	0.1923	0.1220	0.0862	0.0649	0.0556	0.3333	0.1724	0.1087	0.0746	0.0617
C24	0.1923	0.1163	0.0806	0.0617	0.0532	0.2381	0.1282	0.0862	0.0649	0.0556
C25	0.1923	0.1282	0.0926	0.0685	0.0581	0.1351	0.0943	0.0714	0.0575	0.0505
C26	0.1923	0.1282	0.0926	0.0704	0.0610	0.3333	0.1724	0.1087	0.0746	0.0617
C27	0.5000	0.1852	0.1087	0.0746	0.0617	0.3125	0.1515	0.1000	0.0725	0.0610
C28	0.1923	0.1220	0.0862	0.0649	0.0556	0.1852	0.1111	0.0806	0.0633	0.0549
C29	0.3333	0.1852	0.1190	0.0794	0.0649	0.3333	0.1613	0.1000	0.0704	0.0588
C30	0.2000	0.1351	0.0926	0.0667	0.0562	0.2381	0.1351	0.0926	0.0685	0.0581

(2) Table 7 presents the interval value by adopting Equation (3). However, it generated the information lost during the computation; thus, the interval value should be addressed as a crisp value using Equation (4). Therefore, Table 8 expresses the grey relational coefficient generated from Equation (5).

Table 7. Interval value ϑ_{ij}^{*}.

	$[\widehat{\vartheta}_{1j}, \breve{\vartheta}_{1j}]$		$[\widehat{\vartheta}_{2j}, \breve{\vartheta}_{2j}]$		$[\widehat{\vartheta}_{3j}, \breve{\vartheta}_{3j}]$		$[\widehat{\vartheta}_{4j}, \breve{\vartheta}_{4j}]$		$[\widehat{\vartheta}_{5j}, \breve{\vartheta}_{5j}]$	
C1	0.0629	0.0545	0.0562	0.0036	0.0380	0.0069	0.0688	0.0595	0.0697	0.0419
C2	0.0659	0.0663	0.0476	0.0048	0.0375	0.0068	0.0671	0.0394	0.0564	0.0810
C3	0.0614	0.1786	0.0199	0.0036	0.0182	0.0037	0.0744	0.0636	0.0698	0.0316
C4	0.0667	0.0429	0.1012	0.0088	0.0625	0.0138	0.0544	0.0516	0.0497	0.1131
C5	0.0614	0.1764	0.0085	0.0045	0.0136	0.0030	0.0768	0.0434	0.0768	0.0434
C6	0.0550	0.2593	0.0216	0.0029	0.0182	0.0037	0.0774	0.0257	0.0744	0.0636
C7	0.0616	0.0809	0.0258	0.0072	0.0352	0.0065	0.0727	0.0303	0.0744	0.0636
C8	0.0564	0.1783	0.0236	0.0045	0.0236	0.0045	0.0670	0.0145	0.0718	0.0311
C9	0.0424	0.0100	0.0057	0.0018	0.0057	0.0018	0.0433	0.0080	0.0424	0.0078
C10	0.0678	0.0647	0.0637	0.0054	0.0487	0.0088	0.0671	0.0394	0.0624	0.0894
C11	0.0489	0.2565	0.0290	0.0037	0.0242	0.0046	0.0744	0.0636	0.0669	0.0291
C12	0.0584	0.1230	0.0236	0.0045	0.0236	0.0045	0.0768	0.0434	0.0712	0.0247
C13	0.0574	0.1811	0.0180	0.0030	0.0175	0.0036	0.0718	0.0311	0.0706	0.0573
C14	0.0589	0.0233	0.0585	0.0018	0.0433	0.0080	0.0453	0.0084	0.0456	0.0087
C15	0.0564	0.1776	0.0450	0.0054	0.0345	0.0060	0.0716	0.0409	0.0745	0.0336
C16	0.0542	0.2517	0.0386	0.0065	0.0340	0.0059	0.0754	0.0261	0.0817	0.0639
C17	0.0656	0.0357	0.0649	0.0071	0.0529	0.0095	0.0697	0.0419	0.0697	0.0419
C18	0.0658	0.1123	0.0442	0.0058	0.0404	0.0071	0.0695	0.0203	0.0771	0.0577
C19	0.0568	0.0851	0.0228	0.0066	0.0270	0.0048	0.0817	0.0639	0.0744	0.0636
C20	0.0549	0.1201	0.0312	0.0044	0.0270	0.0048	0.0817	0.0639	0.0749	0.0447
C21	0.0663	0.2555	0.0240	0.0029	0.0188	0.0038	0.0762	0.0608	0.0768	0.0434
C22	0.0487	0.0012	0.1036	0.0086	0.0582	0.0127	0.0950	0.1767	0.0974	0.1083
C23	0.0626	0.0671	0.0503	0.0039	0.0424	0.0078	0.0718	0.0311	0.0744	0.0636
C24	0.0706	0.1131	0.1241	0.0054	0.0689	0.0170	0.0766	0.0329	0.0819	0.0456
C25	0.0671	0.0809	0.0538	0.0078	0.0450	0.0078	0.0669	0.0291	0.0676	0.0190
C26	0.0667	0.0507	0.0979	0.0054	0.0564	0.0113	0.0635	0.0287	0.0744	0.0636
C27	0.0697	0.0845	0.0266	0.0058	0.0296	0.0055	0.0846	0.1097	0.0817	0.0639
C28	0.0631	0.1192	0.0276	0.0048	0.0276	0.0048	0.0718	0.0311	0.0785	0.0322
C29	0.0616	0.0871	0.0532	0.0045	0.0411	0.0072	0.0688	0.0595	0.0798	0.0672
C30	0.0642	0.1155	0.0298	0.0063	0.0340	0.0059	0.0648	0.0293	0.0768	0.0434
	$[\bar{\vartheta}_{max}, \tilde{\vartheta}_{max}]$		0.1651	0.4306						
	$[\bar{\vartheta}_{min}, \tilde{\vartheta}_{min}]$		0.0160	0.0094						

Table 8. Grey relational coefficient.

	$[\varepsilon'_{1j}, \varepsilon^*_{1j}]$		$[\varepsilon'_{2j}, \varepsilon^*_{2j}]$		$[\varepsilon'_{3j}, \varepsilon^*_{3j}]$		$[\varepsilon'_{4j}, \varepsilon^*_{4j}]$		$[\varepsilon'_{5j}, \varepsilon^*_{5j}]$	
C1	0.5425	0.7103	0.5734	0.9816	0.6777	0.9578	0.5182	0.6916	0.5147	0.7628
C2	0.5299	0.6678	0.6186	0.9734	0.6807	0.9585	0.5249	0.7740	0.5722	0.6211
C3	0.5491	0.4245	0.8273	0.9816	0.8444	0.9811	0.4970	0.6771	0.5143	0.8116
C4	0.5266	0.7582	0.4154	0.9452	0.5445	0.9119	0.5822	0.7217	0.6065	0.5389
C5	0.5491	0.4275	0.9608	0.9751	0.8965	0.9864	0.4882	0.7563	0.4882	0.7563
C6	0.5791	0.3364	0.8105	0.9867	0.8444	0.9811	0.4863	0.8422	0.4970	0.6771
C7	0.5484	0.6213	0.7717	0.9560	0.6968	0.9612	0.5030	0.8182	0.4970	0.6771
C8	0.5722	0.4248	0.7918	0.9751	0.7918	0.9751	0.5252	0.9075	0.5064	0.8140
C9	0.6492	0.9370	1.0000	0.9953	1.0000	0.9953	0.6433	0.9508	0.6492	0.9521
C10	0.5221	0.6732	0.5393	0.9690	0.6124	0.9452	0.5249	0.7740	0.5448	0.5972
C11	0.6108	0.3388	0.7445	0.9811	0.7858	0.9746	0.4970	0.6771	0.5260	0.8243
C12	0.5629	0.5178	0.7918	0.9751	0.7918	0.9751	0.4882	0.7563	0.5089	0.8477
C13	0.5678	0.4210	0.8467	0.9864	0.8518	0.9816	0.5064	0.8140	0.5112	0.6997
C14	0.5604	0.8557	0.5625	0.9953	0.6433	0.9508	0.6316	0.9475	0.6296	0.9460
C15	0.5722	0.4258	0.6333	0.9690	0.7022	0.9645	0.5073	0.7672	0.4965	0.8014
C16	0.5834	0.3431	0.6733	0.9612	0.7058	0.9651	0.4932	0.8399	0.4717	0.6760
C17	0.5312	0.7913	0.5340	0.9570	0.5898	0.9401	0.5147	0.7628	0.5147	0.7628
C18	0.5304	0.5407	0.6379	0.9658	0.6620	0.9570	0.5154	0.8727	0.4871	0.6984
C19	0.5704	0.6091	0.7989	0.9602	0.7617	0.9734	0.4717	0.6760	0.4970	0.6771
C20	0.5796	0.5239	0.7266	0.9757	0.7617	0.9734	0.4717	0.6760	0.4952	0.7505
C21	0.5282	0.3396	0.7876	0.9867	0.8383	0.9807	0.4905	0.6869	0.4882	0.7563
C22	0.6124	1.0000	0.4094	0.9466	0.5637	0.9189	0.4318	0.4270	0.4253	0.5497
C23	0.5438	0.6650	0.6033	0.9799	0.6492	0.9521	0.5064	0.8140	0.4970	0.6771
C24	0.5112	0.5390	0.3641	0.9690	0.5179	0.8923	0.4889	0.8048	0.4710	0.7466
C25	0.5249	0.6214	0.5850	0.9521	0.6336	0.9522	0.5260	0.8243	0.5230	0.8802
C26	0.5266	0.7254	0.4240	0.9690	0.5724	0.9282	0.5399	0.8262	0.4970	0.6771
C27	0.5147	0.6110	0.7648	0.9658	0.7401	0.9682	0.4624	0.5466	0.4717	0.6760
C28	0.5416	0.5257	0.7566	0.9729	0.7566	0.9729	0.5064	0.8140	0.4825	0.8083
C29	0.5484	0.6037	0.5881	0.9751	0.6576	0.9560	0.5182	0.6916	0.4780	0.6648
C30	0.5372	0.5337	0.7378	0.9623	0.7058	0.9651	0.5343	0.8231	0.4882	0.7563

(3) Before converting the grey relational coefficient into the grey relational grade, the weightage vector must be obtained first. Hence, according to Equation (6), the weights are:

$v_1 = 0.0331$	$v_6 = 0.0336$	$v_{11} = 0.0332$	$v_{16} = 0.0320$	$v_{21} = 0.0328$	$v_{26} = 0.0319$
$v_2 = 0.0330$	$v_7 = 0.0336$	$v_{12} = 0.0344$	$v_{17} = 0.0329$	$v_{22} = 0.0300$	$v_{27} = 0.0321$
$v_3 = 0.0339$	$v_8 = 0.0347$	$v_{13} = 0.0343$	$v_{18} = 0.0328$	$v_{23} = 0.0329$	$v_{28} = 0.0340$
$v_4 = 0.0313$	$v_9 = 0.0418$	$v_{14} = 0.0368$	$v_{19} = 0.0334$	$v_{24} = 0.0301$	$v_{29} = 0.0319$
$v_5 = 0.0347$	$v_{10} = 0.0320$	$v_{15} = 0.0326$	$v_{20} = 0.0331$	$v_{25} = 0.0335$	$v_{30} = 0.0336$

Next, insert the collected weights into Equation (7), for which the grey relational grades are formulated in Table 9.

(4) Applying Equations (8) and (9), the likelihood relationship of $AS1 \succcurlyeq AS2$ can be calculated as follows: $(D_{AS1} \succcurlyeq D_{AS2}) = \max\{1 - \max\{(\tilde{d}_{AS2} - \bar{d}_{AS1})/(\varphi(D_{AS1}) + \varphi(D_{AS2})), 0\}, 0\} = \max\{1 - \max\{(0.972 - 0.555)/((0.555 - 0.581) + (0.972 - 0.683)), 0\}, 0\} = 0$.

Table 9. Grey relational grade.

	$[\bar{d}_1, \tilde{d}_1]$		$[\bar{d}_2, \tilde{d}_2]$		$[\bar{d}_3, d_3]$		$[\bar{d}_4, \tilde{d}_4]$		$[\bar{d}_5, \tilde{d}_5]$	
C1	0.0179	0.0235	0.0190	0.0325	0.0224	0.0317	0.0171	0.0229	0.0170	0.0252
C2	0.0175	0.0220	0.0204	0.0321	0.0225	0.0316	0.0173	0.0256	0.0189	0.0205
C3	0.0186	0.0144	0.0281	0.0333	0.0286	0.0333	0.0169	0.0230	0.0174	0.0275
C4	0.0165	0.0237	0.0130	0.0295	0.0170	0.0285	0.0182	0.0226	0.0190	0.0168
C5	0.0191	0.0149	0.0334	0.0339	0.0312	0.0343	0.0170	0.0263	0.0170	0.0263
C6	0.0194	0.0113	0.0272	0.0331	0.0284	0.0330	0.0163	0.0283	0.0167	0.0227
C7	0.0184	0.0209	0.0260	0.0322	0.0234	0.0323	0.0169	0.0275	0.0167	0.0228
C8	0.0199	0.0148	0.0275	0.0339	0.0275	0.0339	0.0182	0.0315	0.0176	0.0283
C9	0.0272	0.0392	0.0418	0.0417	0.0418	0.0417	0.0269	0.0398	0.0272	0.0398
C10	0.0167	0.0215	0.0172	0.0310	0.0196	0.0302	0.0168	0.0247	0.0174	0.0191
C11	0.0203	0.0112	0.0247	0.0326	0.0261	0.0324	0.0165	0.0225	0.0175	0.0274
C12	0.0194	0.0178	0.0273	0.0336	0.0273	0.0336	0.0168	0.0260	0.0175	0.0292
C13	0.0195	0.0144	0.0290	0.0338	0.0292	0.0337	0.0174	0.0279	0.0175	0.0240
C14	0.0206	0.0315	0.0207	0.0367	0.0237	0.0350	0.0233	0.0349	0.0232	0.0348
C15	0.0187	0.0139	0.0207	0.0316	0.0229	0.0315	0.0166	0.0250	0.0162	0.0261
C16	0.0187	0.0110	0.0216	0.0308	0.0226	0.0309	0.0158	0.0269	0.0151	0.0216
C17	0.0175	0.0260	0.0176	0.0315	0.0194	0.0309	0.0169	0.0251	0.0169	0.0251
C18	0.0174	0.0177	0.0209	0.0316	0.0217	0.0314	0.0169	0.0286	0.0160	0.0229
C19	0.0190	0.0203	0.0267	0.0320	0.0254	0.0325	0.0157	0.0226	0.0166	0.0226
C20	0.0192	0.0173	0.0240	0.0323	0.0252	0.0322	0.0156	0.0224	0.0164	0.0248
C21	0.0173	0.0112	0.0259	0.0324	0.0275	0.0322	0.0161	0.0226	0.0160	0.0248
C22	0.0184	0.0300	0.0123	0.0284	0.0169	0.0275	0.0129	0.0128	0.0128	0.0165
C23	0.0179	0.0219	0.0198	0.0322	0.0213	0.0313	0.0166	0.0267	0.0163	0.0222
C24	0.0154	0.0162	0.0110	0.0291	0.0156	0.0268	0.0147	0.0242	0.0142	0.0225
C25	0.0176	0.0208	0.0196	0.0319	0.0212	0.0319	0.0176	0.0276	0.0175	0.0295
C26	0.0168	0.0231	0.0135	0.0309	0.0183	0.0296	0.0172	0.0263	0.0159	0.0216
C27	0.0165	0.0196	0.0245	0.0310	0.0237	0.0310	0.0148	0.0175	0.0151	0.0217
C28	0.0184	0.0179	0.0258	0.0331	0.0258	0.0331	0.0172	0.0277	0.0164	0.0275
C29	0.0175	0.0192	0.0187	0.0311	0.0210	0.0305	0.0165	0.0220	0.0152	0.0212
C30	0.0181	0.0179	0.0248	0.0323	0.0237	0.0324	0.0180	0.0277	0.0164	0.0254

Afterward, the likelihood relationship can be arranged into a likelihood matrix using Equation (10), and the matrix is then decomposed using MATLAB 10 to obtain the eigenvectors. The higher eigenvector has greater importance in the SBMCC.

Table 10 expresses the likelihood matrix of the aspects, which includes five eigenvectors 0.0983, 0.6393, 0.6758, 0.2725, and 0.2252. Thus, the likelihood relation for the SBMCC aspects can be represented as $AS_3 \succcurlyeq AS_2 \succcurlyeq AS_4 \succcurlyeq AS_5 \succcurlyeq AS_1$. This reveals that technology capabilities (AS3) are given the highest priority, followed by networking and social capabilities (AS2), and capabilities for learning and developing (AS4).

Table 11 indicates that the top-five influential criteria are developing social relations with unfamiliar actors inside or outside the organization for information gathering, experimentation and negotiation (C9), upgrading and integrating technology capabilities, new product development and marketing (C14), the competency to think inventively (C5), building trust, a shared vision and agreement on basic values

(C8), and new approaches in the knowledge for performing management functions and new processes that produce changes in the organization's strategy, structure, administrative procedures, and systems (C13). The ranking of criteria can be stated as: $C_9 \succcurlyeq C_{14} \succcurlyeq C_5 \succcurlyeq C_8 \succcurlyeq C_{13} \succcurlyeq C_{12} \succcurlyeq C_{28} \succcurlyeq C_3 \succcurlyeq C_7 \succcurlyeq C_6 \succcurlyeq C_{30} \succcurlyeq C_{25} \succcurlyeq C_{19} \succcurlyeq C_{11} \succcurlyeq C_1 \succcurlyeq C_{20} \succcurlyeq C_2 \succcurlyeq C_{17} \succcurlyeq C_{23} \succcurlyeq C_{18} \succcurlyeq C_{21} \succcurlyeq C_{15} \succcurlyeq C_{26} \succcurlyeq C_{10} \succcurlyeq C_{29} \succcurlyeq C_{27} \succcurlyeq C_{16} \succcurlyeq C_4 \succcurlyeq C_{24} \succcurlyeq C_{22}$. These results provide significant evidence and a quantitative basis for the case firm to understand innovation in current SBMCC practice.

Table 10. Likelihood matrix for aspects.

	AS1	AS2	AS3	AS4	AS5	Eigenvectors	Ranking
AS1	0.500	0.000	0.000	0.248	0.279	0.0983	5
AS2	1.000	0.500	0.474	0.841	0.888	0.6393	2
AS3	1.000	0.526	0.500	0.902	0.958	0.6758	1
AS4	0.752	0.159	0.098	0.500	0.531	0.2725	3
AS5	0.721	0.112	0.042	0.469	0.500	0.2252	4

Table 11. Likelihood matrix for criteria.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1	0.5000	0.50413	0.4073	0.6530	0.3011	0.4414	0.4477	0.3378	0.0000	0.5917	0.4846	0.3704	0.3642	0.2330	0.5398	0.6017
C2	0.4959	0.5000	0.3904	0.6633	0.2691	0.4283	0.4378	0.3161	0.0000	0.5960	0.4770	0.3523	0.3418	0.2105	0.5392	0.6079
C3	0.5927	0.6096	0.5000	0.8058	0.3482	0.5538	0.5346	0.3869	0.0000	0.7204	0.6160	0.4317	0.4377	0.2388	0.6626	0.7643
C4	0.3470	0.3367	0.1942	0.5000	0.0644	0.2257	0.2740	0.1501	0.0000	0.4375	0.2747	0.1859	0.1454	0.0969	0.3698	0.4213
C5	0.6989	0.7309	0.6518	0.9356	0.5000	0.7167	0.6530	0.5002	0.0000	0.8415	0.7825	0.5475	0.5859	0.3025	0.7928	0.9194
C6	0.5586	0.5717	0.4462	0.7743	0.2833	0.5000	0.4939	0.3401	0.0000	0.6875	0.5652	0.3864	0.3810	0.2064	0.6246	0.7250
C7	0.5523	0.5622	0.4654	0.7260	0.3470	0.5061	0.5000	0.3787	0.0000	0.6565	0.5549	0.4151	0.4166	0.2524	0.6039	0.6799
C8	0.6622	0.6839	0.6131	0.8499	0.4998	0.6599	0.6213	0.5000	0.0000	0.7756	0.7093	0.5372	0.5636	0.3312	0.7313	0.8229
C9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.5000	1.0000	1.0000	1.0000	1.0000	0.9186	1.0000	1.0000
C10	0.4083	0.4040	0.2796	0.5625	0.1585	0.3125	0.3435	0.2244	0.0000	0.5000	0.3595	0.2592	0.2327	0.1498	0.4384	0.4949
C11	0.5154	0.5230	0.3840	0.7253	0.2175	0.4348	0.4451	0.2907	0.0000	0.6405	0.5000	0.3368	0.3188	0.1759	0.5734	0.6665
C12	0.6296	0.6477	0.5683	0.8141	0.4525	0.6136	0.5849	0.4628	0.0000	0.7408	0.6632	0.5000	0.5187	0.3065	0.6937	0.7811
C13	0.6358	0.6582	0.5623	0.8546	0.4141	0.6190	0.5834	0.4364	0.0000	0.7673	0.6812	0.4813	0.5000	0.2693	0.7137	0.8227
C14	0.7670	0.7895	0.7612	0.9031	0.6975	0.7936	0.7476	0.6688	0.0814	0.8502	0.8241	0.6935	0.7307	0.5000	0.8244	0.8911
C15	0.4602	0.4608	0.3374	0.6302	0.2072	0.3754	0.3961	0.2687	0.0000	0.5616	0.4266	0.3063	0.2863	0.1756	0.5000	0.5675
C16	0.3983	0.3921	0.2357	0.5787	0.0806	0.2750	0.3201	0.1771	0.0000	0.5051	0.3335	0.2189	0.1773	0.1089	0.4325	0.5000
C17	0.4885	0.4913	0.4029	0.6268	0.3090	0.4330	0.4401	0.3408	0.0000	0.5714	0.4714	0.3702	0.3646	0.2428	0.5232	0.5775
C18	0.4745	0.4764	0.3689	0.6317	0.2548	0.4037	0.4173	0.3018	0.0000	0.5684	0.4494	0.3360	0.3233	0.2047	0.5127	0.5749
C19	0.5313	0.5400	0.4218	0.7241	0.2795	0.4677	0.4696	0.3311	0.0000	0.6466	0.5249	0.3725	0.3647	0.2099	0.5863	0.6711
C20	0.5017	0.5069	0.3846	0.6864	0.2455	0.4275	0.4382	0.3030	0.0000	0.6120	0.4828	0.3432	0.3294	0.1939	0.5505	0.6286
C21	0.4749	0.4775	0.3217	0.6841	0.1460	0.3711	0.3978	0.2388	0.0000	0.5992	0.4384	0.2859	0.2545	0.1420	0.5268	0.6157
C22	0.2582	0.2406	0.0878	0.3975	0.0000	0.1145	0.1802	0.0604	0.0000	0.3401	0.1611	0.0946	0.0414	0.0354	0.2690	0.3090
C23	0.4834	0.4860	0.3855	0.6352	0.2781	0.4190	0.4294	0.3189	0.0000	0.5742	0.4624	0.3517	0.3422	0.2197	0.5211	0.5814
C24	0.2813	0.2669	0.1325	0.4119	0.0199	0.1578	0.2113	0.1018	0.0000	0.3583	0.1999	0.1331	0.0906	0.0669	0.2938	0.3324
C25	0.5338	0.5405	0.4588	0.6781	0.3651	0.4911	0.4885	0.3881	0.0000	0.6206	0.5301	0.4182	0.4198	0.2753	0.5745	0.6342
C26	0.4137	0.4104	0.3064	0.5486	0.2065	0.3346	0.3579	0.2555	0.0000	0.4941	0.3741	0.2855	0.2671	0.1800	0.4404	0.4889
C27	0.4003	0.3942	0.2339	0.5848	0.0738	0.2743	0.3206	0.1742	0.0000	0.5095	0.3346	0.2170	0.1738	0.1059	0.4356	0.5052
C28	0.5890	0.6022	0.5174	0.7613	0.4061	0.5583	0.5420	0.4252	0.0000	0.6927	0.6052	0.4605	0.4705	0.2866	0.6442	0.7219
C29	0.3953	0.3895	0.2535	0.5567	0.1219	0.2879	0.3255	0.1990	0.0000	0.4911	0.3383	0.2359	0.2032	0.1294	0.4254	0.4840
C30	0.5489	0.5583	0.4618	0.7208	0.3446	0.5019	0.4967	0.3765	0.0000	0.6521	0.5501	0.4126	0.4136	0.2517	0.5996	0.6743

Table 11. *Cont.*

	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	Eigenvectors	Ranking
C1	0.5115	0.5255	0.4687	0.4983	0.5251	0.7418	0.5166	0.7187	0.4662	0.5863	0.5997	0.4110	0.6047	0.4511	0.1664	15
C2	0.5087	0.5236	0.4600	0.4931	0.5225	0.7594	0.5140	0.7331	0.4595	0.5896	0.6058	0.3978	0.6105	0.4417	0.1633	17
C3	0.5971	0.6311	0.5782	0.6154	0.6783	0.9122	0.6145	0.8675	0.5412	0.6936	0.7661	0.4826	0.7465	0.5382	0.2006	8
C4	0.3732	0.3683	0.2759	0.3136	0.3159	0.6025	0.3648	0.5881	0.3219	0.4514	0.4152	0.2387	0.4433	0.2792	0.1031	28
C5	0.6910	0.7452	0.7205	0.7545	0.8540	1.0000	0.7219	0.9801	0.6349	0.7935	0.9262	0.5939	0.8781	0.6554	0.2454	3
C6	0.5670	0.5963	0.5323	0.5725	0.6289	0.8855	0.5810	0.8422	0.5089	0.6654	0.7257	0.4417	0.7121	0.4981	0.1857	10
C7	0.5599	0.5827	0.5304	0.5618	0.6022	0.8198	0.5706	0.7887	0.5115	0.6421	0.6794	0.4580	0.6745	0.5033	0.1862	9
C8	0.6592	0.6982	0.6689	0.6970	0.7612	0.9396	0.6811	0.8982	0.6119	0.7445	0.8258	0.5748	0.8010	0.6235	0.2312	4
C9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.3700	1
C10	0.4286	0.4316	0.3534	0.3880	0.4008	0.6599	0.4258	0.6417	0.3794	0.5059	0.4905	0.3073	0.5089	0.3479	0.1284	24
C11	0.5286	0.5506	0.4751	0.5172	0.5616	0.8389	0.5376	0.8001	0.4699	0.6259	0.6654	0.3948	0.6617	0.4499	0.1675	14
C12	0.6298	0.6640	0.6275	0.6568	0.7141	0.9054	0.6483	0.8669	0.5818	0.7145	0.7830	0.5395	0.7641	0.5874	0.2177	6
C13	0.6354	0.6767	0.6353	0.6706	0.7455	0.9586	0.6578	0.9094	0.5802	0.7329	0.8262	0.5295	0.7968	0.5864	0.2188	5
C14	0.7572	0.7953	0.7901	0.8061	0.8580	0.9646	0.7803	0.9331	0.7247	0.8200	0.8941	0.7134	0.8706	0.7483	0.2762	2
C15	0.4768	0.4873	0.4137	0.4495	0.4732	0.7310	0.4789	0.7062	0.4255	0.5596	0.5644	0.3558	0.5746	0.4004	0.1481	22
C16	0.4225	0.4251	0.3289	0.3714	0.3843	0.6910	0.4186	0.6676	0.3658	0.5111	0.4948	0.2781	0.5160	0.3257	0.1205	27
C17	0.5000	0.5113	0.4581	0.4850	0.5071	0.7090	0.5037	0.6899	0.4582	0.5687	0.5752	0.4070	0.5823	0.4432	0.1630	18
C18	0.4887	0.5000	0.4357	0.4676	0.4914	0.7247	0.4917	0.7021	0.4413	0.5658	0.5723	0.3799	0.5807	0.4211	0.1555	20
C19	0.5419	0.5643	0.5000	0.5369	0.5795	0.8285	0.5517	0.7935	0.4879	0.6321	0.6703	0.4232	0.6662	0.4737	0.1759	13
C20	0.5150	0.5324	0.4631	0.5000	0.5345	0.7902	0.5215	0.7591	0.4618	0.6028	0.6268	0.3940	0.6289	0.4424	0.1641	16
C21	0.4929	0.5086	0.4205	0.4655	0.5000	0.8018	0.4974	0.7660	0.4324	0.5910	0.6131	0.3482	0.6178	0.4031	0.1498	21
C22	0.2910	0.2753	0.1715	0.2098	0.1982	0.5000	0.2752	0.4933	0.2402	0.3651	0.3010	0.1488	0.3409	0.1859	0.0693	30
C23	0.4963	0.5083	0.4483	0.4785	0.5026	0.7248	0.5000	0.7029	0.4507	0.5710	0.5790	0.3931	0.5864	0.4329	0.1596	19
C24	0.3101	0.2979	0.2065	0.2409	0.2340	0.5067	0.2971	0.5000	0.2630	0.3796	0.3256	0.1816	0.3598	0.2163	0.0799	29
C25	0.5418	0.5587	0.5121	0.5382	0.5676	0.7598	0.5493	0.7370	0.5000	0.6122	0.6329	0.4537	0.6339	0.4914	0.1808	12
C26	0.4313	0.4342	0.3679	0.3972	0.4090	0.6349	0.4290	0.6204	0.3878	0.5000	0.4850	0.3262	0.5016	0.3617	0.1332	23
C27	0.4248	0.4277	0.3297	0.3732	0.3869	0.6990	0.4210	0.6744	0.3671	0.5150	0.5000	0.2776	0.5209	0.3263	0.1208	26
C28	0.5930	0.6201	0.5768	0.6060	0.6518	0.8512	0.6069	0.8184	0.5463	0.6738	0.7224	0.5000	0.7122	0.5449	0.2015	7
C29	0.4177	0.4193	0.3338	0.3711	0.3822	0.6591	0.4136	0.6402	0.3661	0.4984	0.4791	0.2878	0.5000	0.3304	0.1220	25
C30	0.5568	0.5789	0.5263	0.5576	0.5969	0.8141	0.5671	0.7837	0.5086	0.6383	0.6737	0.4551	0.6696	0.5000	0.1850	11

5. Theoretical and Managerial Implications

This section presents the theoretical contributions that relate to innovation and SBMCC and provides managerial implications for practice.

5.1. Theoretical Implications

Innovation was found to contribute to SBMCC, as in previous studies [15,20,79]. This study contributes to the literature by prioritizing the capabilities and competencies, thereby revealing a better understanding of innovation in these areas and of SBMCC. This study provides evidence that suggests that innovation in technology capabilities, networking and social capabilities, and the capabilities for learning and developing should be the priorities for a sustainable business.

Firms that have the potential to make products using technologies that challenge the current technology have technology capabilities [80]. Technology capabilities contribute to firm innovation in a highly competitive environment by helping to satisfy customer demand for product and service innovation [81]. Moreover, it affects the business model: Business sustainability drives the firm to adopt management innovation [21,82]. Management innovation refers to the generation or adoption of management processes, practices, structures or techniques that are new to the firm and that affect its performance in terms of innovation, productivity and competitiveness [83,84]. Hence, it changes the way management, techniques and procedures are used to accomplish a specific task or goal and improves on traditional processes and practices. These changes can create sustainable competitive advantages that lead to economic success [85–87].

Previous studies have widely noted that to proceed to a stage of sustainable business, it is necessary to involve a range of actors, including government, societal, nongovernmental organizations, and the community [23,88–91]. Different actors in society and in networks provide learning opportunities, innovation, positive influences, business opportunities and even solutions for complex problems [63]. Thus, innovation of SBMCC requires networking capabilities for collaboration, which facilitates changes at all levels—both inside and outside of the firm [92]. In terms of technology activities, strong networking and social capabilities benefit technology innovation because of the collaboration among actors in a network, as innovation can be achieved by implementing additional capabilities from outside sources [93]. In particular, collaborating with universities and research institutions positively affects product innovation [94]. Specifically, such collaboration allows firms to acquire new scientific knowledge from universities and research institutions, which might benefit product or process innovation. By contrast, failing to understand the benefits of this collaboration may lead to a firm lagging behind in terms of competitive advantage [95].

Learning is the basis of the enhancement of sustainable competitive advantage [96]. Firms that have learning and development capabilities stand a better chance of sensing and efficiently adapting to trends in the marketplace [97]. Capabilities for learning and developing facilitate innovation, which in turn significantly influences the achievement of sustainable business [22]. It ensures business sustainability, *i.e.*, that successes and best practices are transferred and translated into action. In addition, creativity, innovation and adaptability can be leveraged. Learning can be approached from different levels, such as the individual, group, organization and network levels [98,99]. Networks such as industrial associations and industrial forums as discussed above or even competitors can promote innovation for sustainable business. The advantages of collaborating and learning from competitors are sharing knowledge and skills, solving common problems, and gaining more knowledge about competitor strategies [100,101].

5.2. Managerial Implications

This section presents several practical implications. The ranking of the most important criteria are provided in the results section, which offers several managerial insights for the hotel industry. Given the highly competitive nature of the hotel industry, a basic understanding of innovation is necessary for SBMCC. Next, we discuss the implications derived from this study.

The top-ranking criterion is to develop social relations with (culturally) unfamiliar actors inside or outside the organization for information gathering, experimentation and negotiation (C9). Sustainable business may require a re-thinking of the terms of competition and collaboration among the actors

engaged in entire networks. The hotel must facilitate cooperation among the actors in a network, creating a basis for new product and service development and innovation as well as developing advantages associated with lower costs, the preemption of competitors, and a favorable future market position, which can help the hotel achieve increased legitimacy through transparency and collaboration with stakeholders [21,64]. Therefore, management should encourage and facilitate social relations for the sake of improving their products and services; for example, building relationships with research institutions for learning and innovation; building relationships with governments and industrial associations that assist firms in predicting and adapting to new policies and trends in business; collaborating with travel agencies for stable customer sources; and even collaborating with technology-based app developers to receive support from customer app searches.

Upgrading and integrating technology capabilities may benefit new product development and marketing (C14) in several ways; for example, it may decrease the cost of products and services while improving the efficient use of resources [102,103]. Some noteworthy advanced technologies include social media, mobile-friendly content, new technology for traditional points of sale, *etc.*, and these new technologies can help a hotel advertise its products and services to potential customers regardless of distance with low-cost systems for searching and purchasing products. Moreover, technology may assist in changing a firm's business model [104]. Technology is the basis of e-commerce, which is now considered the future of the hotel industry. Cloud computing reduces costs, strengthens security, and allows easy access to information. Currently, mobile phones and tablets can be used to book rooms, plan trips, and search for hotels. Thus, both the accessibility and security of information are critical in business. Hotels that aim to achieve sustainability should consider continuous upgrades in, integration with, and exploitation of new technology.

The ability to think inventively (C5) is an individual skill that is crucial for innovation and that is directed toward finding new solutions to problems. This capability should be strongly developed, as the ability to think innovatively assumes the role of idea generator to achieve change and innovation in hotels. Management and employees with a competency for inventive thinking form the basis of innovation. Therefore, hotels seek and hire inventive employees to improve innovation. Moreover, support and encouragement from management can assist individual employees with thinking inventively, thus creating benefits for firms in terms of innovation and problem-solving. In practice, training courses in problem-solving techniques, such as brainstorming, have proven effective in leveraging inventive thinking and creativity on the part of employees. As employees are the main actors in processing and delivering hotel service to customers, an inventive employee can derive solutions to complex problems and use work experience as a basis for innovation.

Building trust and a shared vision and agreement on basic values (C8) is necessary for collaboration; however, it involves a highly diverse group of stakeholders, which is problematic because of opposing interests and perspectives [21]. Collaboration within a network requires a shared vision and values to achieve uniformity in action. In terms of supporting employees, management is encouraged to be open and responsive to different perspectives—as opposed to closed management attitudes—because it might lead to new knowledge bases for sustainable business management and thus benefit the common agreement on basic values. To achieve openness, managers must be willing to relinquish some control, to find a balance between managing and being managed, and to empower employees. Employees with

more freedom are also free to create innovative solutions that can make the firm more competitive. Hence, the advantages of empowerment in the firm should be emphasized.

Finally, new approaches to knowledge regarding management functions and new processes that produce changes in organizational strategies, structures, administrative procedures, and systems (C13) foster firm process innovation and management innovation. In the hotel industry, process innovation focuses on eliminating waste in delivering services to customers. In this case, implementing technology advancements can improve service quality by providing greater convenience and better experiences to customers while minimizing managerial costs. Currently, the most remarkable technologies that have improved hotel service in terms of process and management are virtual booking and cloud computing. These technologies might help hotels cut costs by reducing the upfront costs associated with setting up the hotel agent, hardware, and operations. More specifically, systems that can be migrated to the cloud and accessed on electronic equipment are desirable to increase customer convenience while improving managerial efficiency and effectiveness. Moreover, the minor details that should be considered include Internet access, sufficient electronics support (adequate and easy-to-reach electrical outlets), *etc.*

6. Conclusions

This study employs IVTFNs and the GRA method to understand innovations in SBMCC by identifying and ranking capabilities and competencies. The capabilities and competencies regarding sustainable business management are presented as several aspects, including competencies for systemic thinking; networking and social capabilities; technology capabilities; capabilities for learning and developing; and capabilities for integrating business, environmental problems, social problems, perspectives and information. These five aspects were considered and evaluated in enhancing the capabilities and competencies for firms to achieve sustainability. The degrees of importance of the aforementioned aspects and criteria are determined by linguistic preference number and the ranking of eigenvectors.

The findings confirm that innovation was found to support SBMCC; this finding implies that innovation in the aspects of technology capabilities, networking and social capabilities, and capabilities for learning and development should be more highly prioritized than other aspects in management decision-making. Specifically, technology capabilities are particularly important in the innovation of management, process, and procedure, all of which can lead to economic success and sustainable business. In the hotel industry, as a result of globalization, the future of doing business is providing service to customers regardless of geographic barriers. Technology enables this possibility for hotels because of e-commerce, which provides virtual reservations, check-in, and ordering. This affirms the sustainability of the business even within the highly competitive environment of the hotel industry. Furthermore, to achieve a sustainable business, a variety of actors must be involved, including government, civic society, nongovernmental organizations, and the community; hence, strong networking and social capabilities require more attention from management. This benefits sustainable business management by fostering long-term collaboration and agreement among the actors and stakeholders in a firm network, which can lead to synergies for development. To exploit a firm's network and social capabilities, the capabilities for learning and development must be translated into action; in addition, innovation is necessary for competitiveness and business success.

This study has contributed to understanding innovation in SBMCC. In practice, establishing a variety of social relations is necessary for a hotel to better adapt to the changes in the business environment.

In addition, applying technology upgrades and integration improves customers' convenience and also plays an important role in business. Technology not only changes management functions and processes, but also reduces the costs, improves service speed, and enhances customer satisfaction. However, the idea of improvements may originate from an individual employee or at the management level; thus, the competency to think inventively is required to encourage and spread the changes to all levels of process and management. Moreover, building trust, a shared vision, and agreement on basic values drives the actors in a network that is dedicated to the common development of sustainable business. In particular, managers are advised to stimulate the entrepreneurial spirit and thinking among employees [105].

This study has certain limitations. First, it was conducted using the extant innovation and SBMCC literature to identify the relevant aspects and criteria; thus, the set of aspects and criteria may not be comprehensive. Second, the sample collection focused only on Taiwanese hotels; hence, external generalizability is limited. Future research would benefit from multi-industry data, which might address potential problems with generalizability. Similarly, the expert sample might be categorized into different industries that may benefit from the comparison and examination of the effective aspects and criteria. Furthermore, to promote and deepen the understanding of SBMCC, additional studies must be investigated to uncover additional valuable aspects and criteria to refine the accuracy of the analysis.

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Author Contributions

Kuo-Jui Wu and Ching-Jong Liao found the phenomenon in the industry and conducted this study. Ming-Lang Tseng and Pei-Jay Chou proposed the research method and finalized the analysis to overcome the uncertainty and incomplete information. Then Kuo-Jui Wu combined the research design and analysis to write the paper for enhancing the understanding of SBMCC. Consequently, all authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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