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Understanding the Sustainability Factors in Critical Information Systems for Disastrous Pandemics: A Knowledge-Based View

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ABSTRACT

During the difficult time of coronavirus outbreaks, global environmental disasters, and financial turmoil, developing and deploying sustainable information systems is a crucial management task for ensuring the functionality of enterprise information processing and thus sustaining competitiveness. This study develops a set of criteria for sustainable information systems using the decision-making trial and evaluation laboratory (DEMATEL) method. By referring to the theory of knowledge-based view and sustainability, this study constructed a research framework in which the selection attributes reflect core knowledge elements of a sustainable information system. An empirical study was performed using the DEMATEL method with data collected from industry experts. The results conclude a cause and effect relationship of the knowledge factors influencing information system sustainability. The study discovered that the economical aspect is a causal factor of environmental aspect and social aspect for sustainability considerations. Furthermore, commercial IT solution knowledge, eco-design knowledge, and workplace safety and health knowledge are the most influential knowledge components for the economic, environmental, and social aspects of information system sustainability, respectively.

Keywords: Sustainability, information system, knowledge-based view, COVID-19, DEMATEL.

INTRODUCTION

Organizations worldwide rely heavily on their information systems for effective operations towards sustainability (Braccini & Margherita, 2019). Information systems are developed with multiple roles in organizational operations (Tang, Tzeng & Wang, 1999). Enterprises employ managerial staff for decision-making using services provided by information systems. Sales and customer service staffs rely heavily on information systems for introducing and promoting products and services to corporate users. These various roles form a value network by participating and contributing to the value of enterprises. In an era of rapid product lifecycles with emergent information technologies such as big data analytics (Weng, 2020a), cloud computing (Wu, Lan & Lee, 2011), and smart mobile devices (Porter & Heppelmann, 2015; Weng, 2020b), information systems become even more critical for enterprises.

As the concept of sustainability emerges, the development and use of information systems are required to be aligned with the goal of corporate sustainability. However, determining the factors influencing the sustainability of information systems is complex, and research in this regard is scant so far. The goal of this paper is to fill this gap by proposing a systematic process to analyze critical factors which affect information system sustainability. Furthermore, since the development and maintenance of information systems are highly knowledge-intensive, knowledge plays an important role in sustainable information systems. This study utilizes a knowledge-based perspective as the theoretical background for extracting the critical factors in the decision process.

The paper begins with a review of the theoretical background of knowledge-based view and sustainability for information systems. Critical factors of sustainable information systems are collected from selected experts in Taiwan. Then it explains the DEMATEL method (Fontela & Gabus, 1976). Following that, the DEMATEL method is applied to analyze the data collected from the experts. Finally, the findings are presented along with the managerial implications of the study and suggestions for further research.

THEORETICAL BACKGROUND

A Knowledge-Based View of Information Systems

The knowledge-based view (KBV) is an outgrowth of resource-based thinking where the concept of resources is extended to include intangible assets and, specifically, knowledge-based resources. Some researchers see KBV as a useful extension of organizational learning to strategy and organization theory, an extension that is capable of informing research and providing new insights into organizational functioning (Eisenhardt & Santos, 2002; Grant, 1996). From the view of an organization, knowledge is absorbed and assimilated information for organizational operations, and intelligence is the knowledge gathered and organized for decision making (Porter & Millar, 1985).

Information systems help firms deal with uncertainty in business decisions and actions (Weng, 2020a). Nowadays, organizations are facing an even greater challenge in decision making than before, as the information to be processed is growing rapidly in volume, velocity, and variety (Johnson, Friend & Lee, 2017). Functions of information systems are cultivated through knowledge acquisition with organizational learning. The knowledge that firms acquire for pursuing and developing business strategy is an important resource for the development of innovative information systems (Porter & Millar, 1985; Smith, McKeen & Singh, 2007).

The most fundamental knowledge for information system development is IT domain knowledge (Hasselbring, 2000; Shen et al., 2004). Participants of the system development lifecycle need to be knowledgeable in information technology to provide decisions on the benefits and risks of various IT solutions. However, IT domain knowledge alone cannot support sustainable information system integration. Enterprise information systems are built to facilitate business processes and regulations in the industry sector of the enterprises. There is complex business domain knowledge for each industry sector. Vendors, integrators, and consultants in the system development value network are expected to be more informative than the corporate users in business domains and provide consultancy to incorporate business knowledge in information systems (Shen et al., 2004).

In addition to IT domain knowledge and business domain knowledge, environment domain knowledge and social domain knowledge are becoming a prominent competence for information system development because of the increasing attention of corporate social responsibility (Choi & Hwang, 2015; Tseng et al., 2019) and corporate citizenship (Carroll, 1998; Di Domenico, Tracey & Haugh, 2009; Kruggel, Tiberius & Fabro, 2020). Green IT (Faucheux & Nicolaï, 2011) and green IS (Anthony Jr, 2019) require substantial environmental domain knowledge. For sustainable information system integration, the knowledge spans resource-efficient methodologies (Anthony Jr, 2019; Fernández-Robin et al., 2019; Huang & Li, 2017; Yu et al., 2020), environment-friendly technologies (Day & Schoemaker, 2011; Mathews & Reinert, 2014), green supply chain operations (Hervani et al., 2005; Hwang et al., 2016; Sarkis et al., 2011), and application of innovative IT for green (Faucheux & Nicolaï, 2011; Lokers et al., 2016; Weng, 2021b).

Sustainability in Information Systems

Sustainability is measured with the triple bottom line (TBL): economical, environmental, and social performances (Braccini & Margherita, 2019). A firm's performances in these three dimensions need to be well balanced. Sustainability has become a critical objective in the entire life cycle of the design, development, and maintenance of corporate products and services (Chiu et al., 2016). However, the studies in the sustainability perspective are still rare for information systems.

Sustainability is often discussed together with corporate ethics. The two topics are tightly related to each other. While the concepts of ethics and sustainability have gained attention from corporations, the perceptions of firms on these concepts are widely divided (Chun, 2019; Searcy & Buslovich, 2014). Sustainability may imply different things to different organizations. This difference is intensified by the fact that different organizations use sustainability reports differently (Searcy & Buslovich, 2014). Also, views of corporate ethics may differ for different organizations. For example, American enterprises tend to emphasize different ethics measures with European enterprises (Chun, 2019). Previous research also pointed out that there are a large number of recognized drivers for the corporate sustainability concept that may affect corporations. The question of how to manage and balance the diversity of these drivers may cause challenges for corporate leaders. (Lozano, 2015).

Sustainability has become a critical measure in the entire life cycle of the design, development, and maintenance of corporate products and services (Chiu et al., 2016). Some measurement models for sustainability have been proposed for information system development, such as the GreenSoft model (Naumann et al., 2011; Venters et al., 2018). However, the studies in the sustainability perspective are still rare for information systems.

Moreover, sustainability is measured with three dimensions: economical, environmental, and social performances (Braccini & Margherita, 2019). A firm's performances in these three dimensions need to be well balanced. Thus in the development and adoption of information systems, factors influencing the performances in these three dimensions need to be considered simultaneously (Venters et al., 2018). These factors often interact and affect each other. Thus, evaluating and comparing the influences of these factors constitute a multiple-criteria decision-making task (Si et al., 2018; Tang et al., 1999; Wu et al., 2011)

RESEARCH METHOD

Decision Criteria

This study conducted literature review and industry expert interviews to collect the possible knowledge components for sustainable information systems. The related area encompasses the triple bottom line of sustainability (Braccini & Margherita, 2019).

Knowledge Criteria of the Economical Aspect

The economical aspect of information systems mainly reflects how information systems are developed and maintained in efficient and effective ways so that the systems can fulfill their intended purposes. To meet the economic considerations, knowledge of commercial IT solutions is essential for selecting the available commercial IT products and services that fit the budget and time constraints (Omoumi et al., 2021). Also, since, in most cases, information systems are digital automation of business processes, competence with business process knowledge is also mandatory (Baiyere, Salmela & Tapanainen, 2020). Furthermore, knowledge about the methodology and practices of software engineering is required for the entire lifecycle of system development. Finally, knowledge of system integration is indispensable to deal with the integration of various software and hardware components and subsystems.

Knowledge Criteria of the Environmental Aspects

The environmental aspect of sustainable information systems focuses on enhancing the environmental benefit in the lifecycle of information system development. Green IT knowledge is required for adopting the methodologies of system development that minimize environmental impacts (Huang, 2009). Green business model knowledge helps the integration of information systems with environmental value creation (Sarkar, Qian & Peau, 2020). Green software engineering knowledge (Naumann et al., 2011; Venters et al., 2018) and eco-design knowledge (Brambila-Macias & Sakao, 2021; Mendoza et al., 2017) provide models and disciplines for environmental-friendly and eco-friendly information systems.

Knowledge Criteria of the Social Aspect

The knowledge components of the social aspect are crucial to coping with the possible social impacts of information systems. Corporate citizenship knowledge is useful in guiding the development of information systems toward social responsibility (Akbari & McClelland, 2020). In the entire system development lifecycle, workplace safety and health knowledge are required for the safety and health of all stakeholders (Sorensen et al., 2018). Social, competitive knowledge (Rajković et al., 2021) and social marketing knowledge (Shawky et al., 2019) provide competitive intelligence and effective marketing campaigns through social activities and media; thus, these knowledge components can promote the social credence of information systems.

Decision Method

The decision-making trial and evaluation laboratory (DEMATEL) method is an MCDM technique with applications in various areas (Lin et al., 2011; Wu et al., 2011). The DEMATEL method not only delivers a means to visualize the causal relationships among criteria through a cause-effect diagram but also evaluates the intensity to which the factors influence each other (Si et al., 2018). Thus, it is suitable for the purpose of this study.

The regular DEMATEL (Fontela & Gabus, 1976; Si et al., 2018) method contains four main steps: assessing the initial direct relation matrix by experts, normalizing the direct relation matrix, obtaining the total relation matrix, and producing a causal diagram (Si et al., 2018; Wu et al., 2011).

Let vector D and vector R, respectively, denote the sum of rows and the sum of columns from the total relation matrix obtained. The dimension (D+ R), named prominence, shows how much importance the factor has. The dimension (D−R), named relation, divides factors into a cause group and an effect group. A factor is in the cause group if its (D−R) value is positive. A factor is in the effect group if its (D−R) value is negative (Fontela & Gabus, 1976; Wu et al., 2011).
The computing steps of the DEMATEL method can be further described as follows.

1. The generation of the direct relation matrix

The magnitude of the relationship between factors i and j can be represented by scales according to the following numerical levels: no influence = 0, low influence = 1, medium influence = 2, high influence = 3, and very high influence = 4.

An initial direct relation matrix Z is an n×n matrix obtained by averaging the pair-wise comparisons of experts in terms of impacts and directions between factors, in which z_{ij} is expressed as the degree to which the factor i affects the factor j, where $1 \leq i, j \leq n$.

$$Z = \left[z_{ij}\right]_{n \times n} \tag{1}$$

where all principal diagonal elements are equal to zero in Z.

2. The normalization of the direct relation matrix

The computation of the normalized direct relation matrix $Y = [y_{ij}]$, where $0 \leq y_{ij} \leq 1$, is performed through equations (2) and (3), in which all principal diagonal elements are equal to zero.

$$Y = f \times Z \tag{2}$$

Where

$$f = \frac{1}{max_{1 \leq i \leq n} \sum_{j=1}^{n} z_{ij}} \tag{3}$$

3. The computation of the total relation matrix

Once the normalized direct relation matrix Y is obtained, the total relation matrix T can be acquired by using equation (4), in which I denotes the n×n identity matrix and $(I - Y)^{-1}$ is the inversion of the (I – Y) matrix.

$$T = Y \times (I - Y)^{-1} \tag{4}$$

4. The exhibition of the causal diagram

The sum of rows and the sum of columns are separately denoted as D and R in equations (5)-(7):

$$T = \left[t_{ij}\right]_{n \times n}, \quad i, j = 1, 2, \ldots \ldots, n \tag{5}$$

$$D = \left[\sum_{j=1}^{n} t_{ij}\right]_{n \times 1} \quad (6)$$

$$R = \left[\sum_{i=1}^{n} t_{ij}\right]_{1 \times n} \quad (7)$$

In these equations, vector D and vector R are the sums of rows and the sum of columns from the total relation matrix T, respectively.

A cause and effect diagram is also called a causal diagram and is depicted using the values of D and R obtained from equations horizontal dimension (D + R) is obtained by adding R to D, and the vertical dimension (D −R) is obtained by subtracting R from D.

Decision Process
Table 1 exhibits the decision framework.

Table 1: Knowledge factors for information system sustainability.

Aspect		Key Knowledge Component
A1.Economical aspect	K01	Commercial IT solution knowledge
	K02	Business process knowledge
	K03	Software engineering knowledge
	K04	System integration knowledge
A2.Environmental aspect	K05	Green IT knowledge
	K06	Green business model knowledge
	K07	Green software engineering knowledge
	K08	Eco-design knowledge
A3.Social aspect	K09	Corporate citizenship knowledge
	K10	Workplace safety and health knowledge
	K11	Social, competitive knowledge
	K12	Social marketing knowledge

Source: This study.

The experts then assessed the influence of each aspect and factor in pairs by using equation (1) of the DEMATEL method described above. The final results were computed using equations (2)-(7). The results of the DEMATEL method were then utilized to evaluate the sustainability scores of three critical information systems for coping with the COVID-19 outbreaks. The meaning and significance of these results are elaborated as follows.

RESULTS

Based on the knowledge elements stated above, as in Table 1, this research has further employed the DEMATEL method to capture the complex relationships among these factors. As the purpose of the study was to analyze the decision factors and their causal relationships in information system sustainability, a fourth aspect, A4 for information system, was added into the DEMATEL calculation of the relationships among aspects.

The collected pairwise comparison results have been obtained (the comparison mechanism has been described at step 1 of the DEMATEL method), and that the preliminary average direct relation matrix is shown in Tables 2a-2d. Based on the direct relation matrix, these numbers are normalized continuously into the normalized relation matrix (calculated by equations (2) and (3)). The total relation matrix is then obtained by using equation (4).

The Initial Direct Relation Matrices

The collected pairwise comparison results were obtained (the comparison mechanism has been described at step 1 of the DEMATEL method), and that the preliminary average direct relation matrix is shown in Tables 2a-2d.

Table 2a: Direct relation matrix of the four aspects.

	A1	A2	A3	A4
A1	0.000	2.286	2.571	2.714
A2	2.143	0.000	3.714	2.000
A3	1.857	3.286	0.000	2.000
A4	2.429	1.429	1.429	0.000

Source: This study.

Table 2b: Direct relation matrix of economical aspect.

	K01	K02	K03	K04
K01	0.000	1.714	2.857	2.714
K02	1.286	0.000	1.857	1.857
K03	2.857	2.000	0.000	2.857
K04	2.714	1.429	2.714	0.000

Source: This *study*.

Table 2c: Direct relation matrix of environmental aspect.

	K05	K06	K07	K08
K05	0.000	1.571	2.714	1.857
K06	1.571	0.000	2.143	3.000
K07	3.143	1.571	0.000	2.429
K08	3.000	3.143	3.286	0.000

Source: *This* study.

Table 2d: Direct relation matrix of the social aspect.

	K09	K10	K11	K12
K09	0.000	3.429	1.857	2.000
K10	3.714	0.000	2.429	3.000
K11	2.143	1.714	0.000	3.143
K12	2.714	2.286	3.571	0.000

Source: This study.

The Normalized Direct Relation Matrices

The direct relation matrices were normalized continuously into the normalized relation matrices by using equations (2) and (3). The results are shown in Tables 3a-3d.

Table 3a: Normalized direct relation matrix of the four aspects.

	A1	A2	A3	A4
A1	0.000	0.291	0.327	0.345
A2	0.273	0.000	0.473	0.255
A3	0.236	0.418	0.000	0.255
A4	0.309	0.182	0.182	0.000

Source: This *study*.

Table 3b: Normalized direct relation matrix of economical aspect.

	K01	K02	K03	K04
K01	0.000	0.222	0.370	0.352
K02	0.167	0.000	0.241	0.241
K03	0.370	0.259	0.000	0.370
K04	0.352	0.185	0.352	0.000

Source: This study.

Table 3c: Normalized direct relation matrix of environmental aspect.

	K05	K06	K07	K08
K05	0.000	0.167	0.288	0.197
K06	0.167	0.000	0.227	0.318
K07	0.333	0.167	0.000	0.258
K08	0.318	0.333	0.348	0.000

Source: *This* study.

Table 3d: Normalized direct relation matrix of the social aspect.

	K09	K10	K11	K12
K09	0.000	0.375	0.203	0.219
K10	0.406	0.000	0.266	0.328
K11	0.234	0.187	0.000	0.344
K12	0.297	0.250	0.391	0.000

Source: This study.

The Total Relation Matrices

After the normalized relation matrices were obtained, the total relation matrices were then computed by using equation (4). The results are shown in Tables 4a-4d.

Table 4a: Total relation matrix of the four aspects.

	A1	A2	A3	A4
A1	1.788	2.163	2.317	2.103
A2	2.080	2.040	2.505	2.130
A3	1.934	2.195	2.034	1.999
A4	1.592	1.621	1.724	1.401

Source: This study.

Table 4b: Total relation matrix of economical aspect.

	K01	K02	K03	K04
K01	1.922	1.662	2.283	2.274
K02	1.540	1.077	1.652	1.654
K03	2.263	1.740	2.087	2.358
K04	2.110	1.582	2.195	1.936

Source: This study.

Table 4c: Total relation matrix of environmental aspect.

	K05	K06	K07	K08
K05	0.667	0.690	0.909	0.782
K06	0.879	0.614	0.944	0.930
K07	1.004	0.762	0.775	0.898
K08	1.173	1.023	1.222	0.872

Source: This study.

Table 4d: Total relation matrix of the social aspect.

	K09	K10	K11	K12
K09	1.551	1.675	1.612	1.662
K10	2.111	1.646	1.907	1.985
K11	1.658	1.486	1.384	1.670
K12	1.933	1.739	1.886	1.642

Source: This study.

The Cause and Effect Relations

After the total relation matrices were obtained by using equation (4), equations (5)-(7) were utilized to compute the cause and effect relations. The results are shown in Table 5.

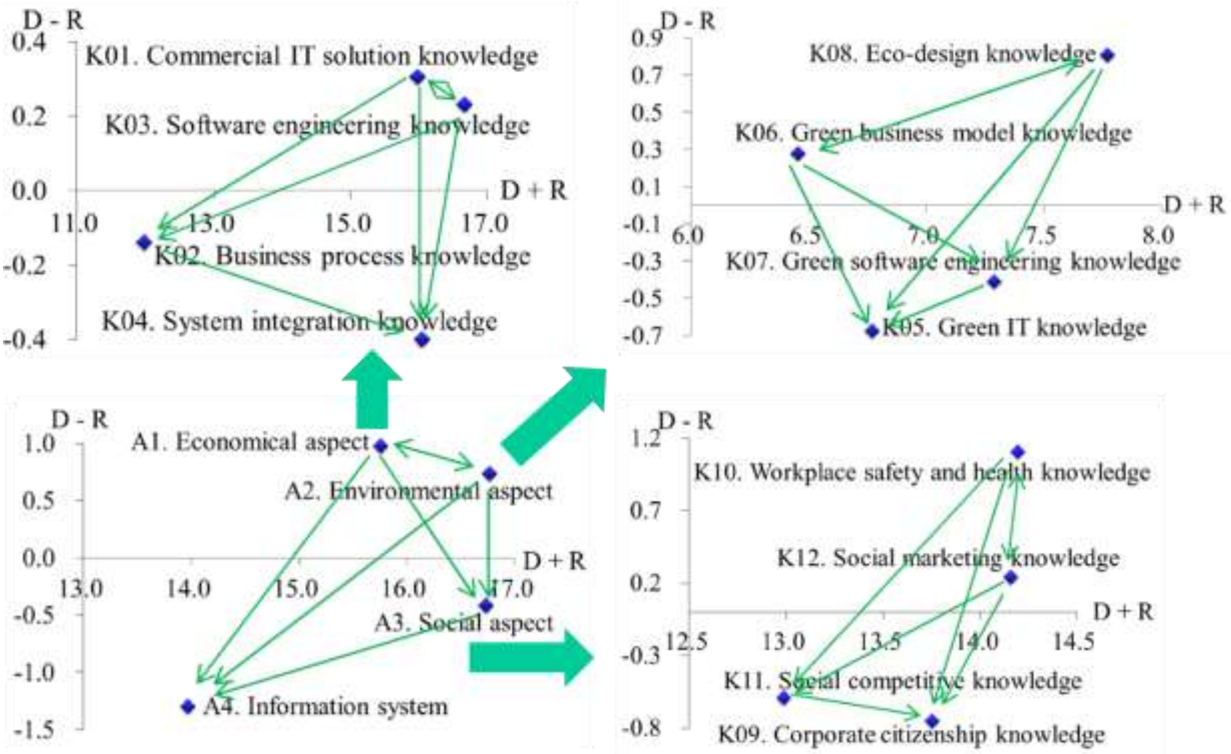
Table 5: Prominence and relation values.

Factor	D	R	D + R	D - R
A1	8.371	7.393	15.764	0.978
A2	8.755	8.019	16.773	0.736
A3	8.162	8.580	16.742	-0.418
A4	6.337	7.633	13.971	-1.296
K01	8.141	7.835	15.976	0.306
K02	5.922	6.061	11.983	-0.139
K03	8.448	8.216	16.664	0.232
K04	7.822	8.221	16.044	-0.399
K05	3.047	3.724	6.771	-0.676
K06	3.367	3.089	6.455	0.278
K07	3.439	3.850	7.290	-0.411
K08	4.290	3.481	7.771	0.810
K09	6.500	7.253	13.753	-0.754
K10	7.649	6.546	14.195	1.104
K11	6.198	6.789	12.988	-0.591
K12	7.200	6.959	14.159	0.241

Source: *This* study.

The Causal Diagram

Finally, the causal diagram is produced and displayed in Figure 1 by mapping the dataset of (D + R, D-R) in Tables 5. Based on the data set shown in Table 5, we obtained the bottom left panel of Figure 1, which demonstrates the causal relationships among the four aspects. The other three panels of Figure 1 demonstrate the causal relationships among the components within the aspects of economical (upper left panel), environmental (upper right panel), and social (lower right panel), respectively.



Source: This study.

Figure 1: Causal diagram for the sustainability in information systems.

The Sustainability scoring of Critical Information Systems

Based on the knowledge factors analyzed above as in Table 5, this study then further invited the experts to evaluate three critical information systems deployed for the COVID-19 pandemic. The scoring is scaled from 1 (for low score) to 5 (for high score)—the average scores are computed in Table6.

Table 6: Sustainability rating of critical information systems.

Knowledge factor		Normalized D + R as weight	Information system 01: Public health status and infection monitoring		Information system 02: Logistics and distribution of critical healthcare materials		Information system 03: Remote medical and healthcare services	
			Average score	Weighted score	Average score	Weighted score	Average score	Weighted score
K01	Commercial IT solution knowledge	0.084	3.429	0.289	3.714	0.313	3.286	0.277
K02	Business process knowledge	0.063	2.571	0.162	3.286	0.208	2.857	0.181
K03	Software engineering knowledge	0.088	3.286	0.289	3.429	0.301	2.714	0.238
K04	System integration knowledge	0.085	2.714	0.230	2.857	0.242	3.000	0.254
K05	Green IT knowledge	0.081	3.143	0.256	2.857	0.233	3.286	0.268
K06	Green business model knowledge	0.078	2.857	0.222	3.000	0.233	3.286	0.255
K07	Green software engineering knowledge	0.088	2.714	0.238	2.571	0.226	2.857	0.251
K08	Eco-design knowledge	0.094	2.571	0.240	2.571	0.240	3.000	0.281
K09	Corporate citizenship knowledge	0.085	2.143	0.182	2.571	0.218	3.571	0.303

K10	Workplace safety and health knowledge	0.088	2.286	0.200	2.286	0.200	3.571	0.313
K11	Social competitive knowledge	0.080	2.000	0.160	2.000	0.160	3.143	0.252
K12	Social marketing knowledge	0.087	2.143	0.187	2.429	0.212	3.286	0.287
	Total score	1.000		2.655		2.786		3.158

Source: This study.

Table 6 shows that the sustainability scores of all the three information systems are 2.655, 2.786, and 3.158, respectively, which are medium by the scale of 1 to 5. The score in each knowledge factor can be used as a reference for further improvement of the sustainability in these information systems.

DISCUSSION

By examining Figure 1 and Table 5, each factor can be analyzed, and its impact on the overall sustainability discussed. Hence, the critical knowledge components influencing the sustainability of information systems can be determined, as is discussed next.

The Cause Group and the Effect Group

The results shown in the causal diagrams in Figure 1 have discovered the cause and effect relationships of these core knowledge elements in driving information systems toward sustainability. It is observed that, by looking at these causal diagrams, the factors can be divided into a causal and an effective group. The cause group includes factors with positive (D – R) values, while the effect group includes factors with negative (D – R) values. Since the causal factors have a net impact on the overall framework, their performance can greatly influence the overall goal. Thus, it is generally accepted that the factors in the cause group should be closely monitored. Conversely, the factors in the effect group tend to be easily affected by others, which makes them unsuitable as critical impact factors.

Thus, the cause group contains economical aspect (A1), environmental aspect (A2), commercial IT solution knowledge (K01), software engineering knowledge (K03), eco-design knowledge (K08), green business model knowledge (K06), workplace safety, and health knowledge (K10), and social marketing knowledge (K12).

The effect group includes social aspect (A3), information system (A4), business process knowledge (K02), system integration knowledge (K04), green software engineering knowledge (K07), green IT knowledge (K05), competitive social knowledge (K11), and corporate citizenship knowledge (K09).

Therefore, the cause and effect structure in Figure 1 implies that among the knowledge components, K01, K03, K06, K08, K10, and K12 are the main knowledge components in leading information systems to move toward sustainability. Subsequently, knowledge components K02, K04, K05, K07, K09, and K11 are not causal but affected. Thus, they are derived and influenced by the other knowledge components for determining the sustainability of information systems.

Analysis of the Aspects

As the results exhibited in Table 5 and the bottom left panel of Figure 1 demonstrate, among the four aspects, the economical aspect (A1) has the highest (D – R) value, which means that it has a greater impact on the entire framework than it receives from the other aspects. However, the environmental aspect (A2) and social aspect (A3) are the two factors with higher (D + R) values. Thus they are of high importance in the framework.

The results also reveal that the environmental aspect (A2) is the most important causal factor (with the highest D value) among the three bottom lines, and generates a competitive impact (positive D – R), thus making it the most significant aspect of knowledge to the sustainability of information systems. These guidelines of improvement direction will lead information systems toward a more sustainable level.

These results imply that while knowledge components in the environmental aspect and social aspect are important regarding information system sustainability, they are nevertheless influenced by knowledge components in the economical aspect. Therefore, the utilization of environmental and social domain knowledge in information system development is substantially affected by economical domain knowledge.

Analysis of Knowledge Components in the Economical Aspect

The results exhibited in Table 5 and the upper left panel of Figure 1 show that, among the knowledge components in the economical aspect, commercial IT solution knowledge (K01) and software engineering knowledge (K03) have positive (D – R) values and thus are causal factors.

The commercial IT solutions for contemporary information systems include many turn-key products which already encapsulate business processes (K02) and can facilitate system integration (K04). The system analysis and design phase in software engineering also perform business process analysis. System integration needs to be guided and planned in the subsystem development of software engineering.

Thus, with respect to the economical aspect, commercial IT solution knowledge is the most influential component and should be enhanced first, followed by software engineering knowledge, as shown in Figure 1. These knowledge components expedite successful information system development and reduce the waste of resources and time; thus, they help promote the sustainability of information systems.

Analysis of Knowledge Components in the Environmental Aspect

As the results exhibited in Table 5 and the upper right panel of Figure 1 indicate, among the knowledge components in the environmental aspect, eco-design knowledge (K08) and green business model knowledge (K06) have positive (D – R) values and thus are causal factors.

Figure 1 also shows that eco-design knowledge is the most important component with the highest (D + R) value. It has an influence on green business model knowledge (K06), green software engineering knowledge (K07), and green IT knowledge (K05). This indicates that eco-design knowledge is the stimulating knowledge component of the other environmental domain knowledge and should be improved and promoted first, followed by green business model knowledge, as shown in Figure 1. Eco-design knowledge is tacitly embedded in many green business practices and is essential for the environmental-friendliness of the system development lifecycle.

Analysis of Knowledge Components in the Social Aspect

The results exhibited in Table 5 and the lower right panel of Figure 1 show that, among the knowledge components in the social aspect, workplace safety and health knowledge (K10) and social marketing knowledge (K12) have positive (D – R) values and thus are causal factors.

Figure 1 also shows that workplace safety and health knowledge is the most prominent component with the highest (D + R) value. It has an influence on social marketing knowledge (K12), competitive social knowledge (K11), and corporate citizenship knowledge (K09). This indicates that workplace safety and health knowledge are the causal knowledge components of the other social domain knowledge and should be improved and promoted first, followed by social marketing knowledge, as shown in Figure 1. Particularly, facing the disastrous COVID-19 outbreaks nowadays, workplace safety and health knowledge are indispensable and inevitable for the social sustainability of the system development lifecycle. Its profound impact on the other social domain knowledge and the entire decision framework of sustainable information systems will continue to extend.

CONCLUSIONS

In conclusion, knowledge factors are essential to the success of engineering and management of information systems. However, past studies have not provided sufficient analysis of the interaction relation among them. Moreover, information system sustainability has emerged in recent years, and hence its influencing factors remain unclear. Through the analysis performed, this study has made contributions in the following perspectives: (1) linking knowledge-based view with sustainability; (2) defining the critical knowledge elements for information system sustainability; (3) investigating the interrelationship of these critical knowledge elements; (4) demonstrating DEMATEL method as an effective multiple criteria decision-making tool in supporting the exploration of the cause and effect relationship in a complex decision system; (5) analyzing critical impacts based on the generated causal diagram and providing improvement strategies accordingly.

This study analyzes factors affecting the sustainability of information systems from a knowledge-based perspective. Although knowledge is a critical intangible resource in the development of information systems, other factors are worth further attention (Weng, 2021a). Moreover, the analyzing process in this study can be applied to specialized systems such as medical information systems and smart healthcare-related systems (Weng, 2021b). Further investigations into these topics are recommended.

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