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The Integration of ICT Tools for Collaborative Partners Selection

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Abstract. Due to rising competition in global marketplaces, it is necessary to select appropriate partners to build Collaborative Networks (CNs). Partner selection based on partner-related characteristics is difficult to quantify due to the difficulty of giving a numerical value to these variables. Furthermore, present frameworks for partner selection do not make use of the benefits of DSS and ICT technologies. As a result, developing an ICT-based partner selection strategy before establishing the collaborative network is essential for operating a successful and effective collaborative network. This study provides a significant implication to the DSS domain as the framework embeds a model of partner-related selection criteria by utilizing the ICT tools in evaluating partner selection criteria.
Keywords: Decision support system, partner selection framework, collaborative network, ict tools, information management and library management.

1 Introduction

The Industry Revolution 4.0 initiative pushes the industry to become smarter in decision-making and more agile in terms of volume of production and adaptation, as well as more collaborative with customers, companies, and suppliers, sustainable development, and higher environmental and resource-based optimization (Nikghadam-Hojjati & Barata, 2019; Shrouf et al., 2014). In a quickly changing market, dynamic collaboration is a quick response to a collaborative opportunity. As a result, current innovations alter the design and operation of collaborative networks, and defining the correct criteria for partner selection to work together in collaborative networks, as well as supporting decision-makers in picking possible partners, is a must (Salah et al., 2016; Souhir et al., 2018). Partners have a huge impact on the efficacy of collaborative networks. As global markets need quick and imaginative partnerships across organizations, the rapid rise of ICT-enabled technologies has trans-

formed the way firms function. Despite the importance of ICT in organizations, decision-makers in collaborative networks face a number of challenges. One of the issues is that they are still working to define the appropriate and appropriate criteria for partner selection (Polyantchikov et al., 2017)). As a result, choosing partners becomes a significant issue. There was also an issue with choosing compatible partners (Scott et al., 2015). The selection of partners can be viewed as a multi-attribute decision-making problem involving variable criteria and a wide variety of alternatives. However, decision-makers are typically uncertain about their preferences because of changing criteria and incomplete candidate information.

Adding to this, the criteria studied in this research are related to intangible criteria, which are not easy to measure compared to tangible criteria. Decision-makers may also face difficulties in gathering or analyzing the information about potential partners as this information may be located in different places or were not adequately organized. Therefore, the Decision Support System (DSS) is required to help decision-makers compile various types of information about partner selection criteria. All data from several different sources will be located in a computerized-based system that can be used in decision-making activities for managing, operating, and planning in an organization. DSS may assist decision-makers by supporting management decisions quantitatively, instead of based on individual intuition and experience.

As a result, there is a need to establish a partner selection framework that incorporates ICT tools to assist decision-makers in evaluating partner selection criteria in order to limit the risk of picking incompatible partners. The framework will assist decision-makers by giving processes or activities to consider when selecting potential partners with the assistance of a decision support system.

In the next section, the study through a critical review of related studies on the partner selection process will be discussed. It begins with an overview of the influence of ICT on inter-organizational collaboration followed by collaborative networks then discussed, and nine partner selection frameworks are presented followed by a detailed discussion of partner selection criteria, particularly collaborator-related criteria. ICT tools for collaborating on the concept related to DSS and the application of DSS in collaborator selection are also discussed in the next section. Finally, this chapter introduces the research model for this study which is derived from the literature review.

2 Literature Review

This section provides a discussion on the study on partner selection criteria. It begins with the classification of the criteria, and issues related to the partner selection criteria, the justification for focusing on partner-related criteria and lastly the process of conducting partner selection.

2.1 Partner Selection Criteria

Geringer (1991) classified partner selection criteria into two categories: partner-related criteria and task-related criteria. 'Task-related' or 'operation-related' criteria refer to "variables which are intimately related to the viability of a proposed venture's operation regardless of whether the chosen investment mode involves multiple partners" (Geringer, 1988, 1991; Lou, 1998). In other words, it is associated with the strategic attributes of a partner and influences the operational skills and resources needed for competitive collaboration success (Dong & Glaister, 2006). 'Partner-related' or 'co-operation-related' criteria are those "associated with the efficiency and effectiveness of partners' co-operation" (Geringer, 1991). This category of criteria usually represents organizational attributes such as trust, commitment, size of organizations and reputation. Examples of these criteria include corporate culture and trust between partners. Partner-related criteria relate to the quality and effectiveness of partners (cooperation) in multiple collaborations, encouraging the option of the best partner to match the focal firm. Additionally, this criterion is also considering issues such as the national and corporate culture of the partner, compatibility and trust between management teams, and the structure and size of the partner organization. The variables may focus on the country and corporate culture, size, and structure of the partner as well as confidence among management teams.

According to Al-Khalifa and Petersen (1998), the history of the partners should also be considered. However, despite the extensive discussion of partner-related criteria in the previous study in selecting partners, there were few studies that measured partner-related criteria. It is possible to use ICT tools in the selection of partners in Industry 4.0 because these tools enable organizations to evaluate criteria related to partners. This is possible because of the wide range of low-cost ICT tools on the market. Technology such as knowledge exchange and streaming allow organizations to obtain more useful resources or information about their future partners. Preventing failure in the early stages of a partnership is also dependent on partner-related criteria. In order to identify potential partners, organizations should take into consideration the use of ICT methods. It aids managers in making quick and efficient decisions about which business partners to work with. As a result, these parameters tend to be interpreted more loosely. An organization's consideration of the use of ICT methods to identify potential partners' characteristics or criteria is essential, as it can aid managers in making quick and efficient decisions. Technology such as social media has a significant impact because it provides an assessment of the characteristics of a potential business partner.

2.2 ICT Tools for Collaboration

ICT allows knowledge and know-how to be developed and exchanged over long distances to a far greater degree than was previously possible. Several ICT tools for collaboration have been identified and listed by previous researchers. This study employs (2003) and (Vartiainen & Jahkola, 2013) analysis categories of ICT tools based on the fundamental interactions or group processes they should support. Group pro-

cesses include communication sharing of information, coordination, cooperation, and group-based processes, as shown in Table 1. The classification given in Table 1 will be used in this study as guidance to measure the partner selection criteria. The following section discusses the criteria used by organizations in selecting their potential partners.

Table 1: ICT Tools for collaboration
(adapted from (Andriessen, 2003) and (Vartiainen & Jahkola, 2013)

System	Function	Example
Communication system	Technologies that provide and enable communication between geographically scattered people with low cost, easy and fast	Email, instant messaging, SMS, message board, phone, VOIP, teleconference, web conferences
Information sharing systems	Technologies that enable large amounts of data to be stored and retrieved quickly, reliably, and cheaply	Document repositories, share points/intranet, Wiki, social media tools, newsletter/ mailing lists, blogs, FTP, CRM, SAP, network drives, document/screen applications for Web conferences
Co-ordination systems	Technologies that facilitate distributed teamwork with synchroniser to integrate the work processes of a team	Shared group calendars, availability of information, shared task list, project management tools and ticketing system
Co-operation systems	Technologies that provide document-sharing and co-authoring facilities in improving teamwork	Google Drive, Google Docs, Google Sheets, Dropbox
Group maintenance systems	Technologies that enable people to meet each other between geographically distributed teams	Permanently open Skype/ web link between two sites/virtual worlds

2.3 Collaborative Networks Model

Five established collaborative network models have been investigated to identify the strengths and weaknesses of each framework, phases involved in the framework, the contribution of the framework and the integration of computerized decision-making in the framework. The summarization frameworks are shown in Table 2. Based on these frameworks, a new framework will be designed to fill in the gap in the current research.

Table 2: Summary of literature review of the collaborative network framework

Year	Authors	Framework	Domain	Contribution	Guided decision-making
2022	Qi, Y., Zhang, X., Hu,	Collaborative Innovatio	Research collaboration	Topic analysis and link prediction-based framework were created. The framework	Yes

Year	Authors	Framework	Domain	Contribution	Guided decision-making
	Z. et al.	n	innovation	extracts correlated scientific and technological topics, author institutions, and patentees from a corpus of papers and patents. These organisations are ranked using two innovation indicators—capability and openness. A link prediction	
2019	Han et al. (Han et al., 2019b)	Collaborative and Knowledge Networks Partner Selection	Collaborative Networks	method identifies missing links with a high likelihood of fruitful cooperation in two integrated author-patentee collaboration networks. Proposed a useful and new partner selection method based on collaborative networks and information which considered the optimization of network deconstruction.	Not mentioned
2016	Shamsuzzoha et al. (Shamsuzzoha et al., 2016)	Net-Challenge ICT Platform Framework	Virtual Organizations (VO)	Provide ICT solutions in the collaborative business environment (establishing communication infrastructure and smart process monitoring between business partners within the VO network)	Not mentioned
2015	Shevtshenko et al. (2015)	A framework of sustainable realization of collaborative projects	Collaborative Networks	This paper provides a conceptual model for sustainable collaborative projects for SMEs from the machinery sector which follows the criteria for new members to join a network partner (NP)	Yes
2014	Américo Azevedo et al., (Américo	ADaptive Virtual ENterprise ManufacT	Manufacturing	Design a three-layer architecture information system (IS) and implemented it with cloud-based data storage.	Yes

Year	Authors	Framework	Domain	Contribution	Guided decision-making
	o Azevedo et al., 2014b)	Uring Environment (ADVENTURE)			

As shown in Table 2, most frameworks are domain-specific. These frameworks also provided ideas for supporting Collaborative Networks. Previous works have contributed to understanding CNs, but they have limitations. Despite having a partner selection module/process, several existing frameworks do not require a model to evaluate partner-related criteria. Collaborative organizations need a secure environment to work on CN projects during formation. As there is no face-to-face communication or physical meeting before collaborating, organizations must find a way to determine the attitude or characteristics of their potential partners. Due to limited information about potential partners' backgrounds, CN must provide a supportive environment for them to 'know each other' before collaborating on a project. Thus, partner-related or intangible criteria must be considered when developing the CN framework to avoid future failed collaboration. The table shows that most frameworks are manufacturing-related. However, a generic framework for many domains is needed. Guided decision-making helps decision-makers make quality decisions. It's important to establish a standard knowledge framework. Literature shows several frameworks for operating and developing collaborative networks. Still, these frameworks do not fully use ICT platforms or tools for the partner selection process. Before operating a collaborative network, it is crucial to develop an ICT-based partner selection model for effective and efficient management. Integrating ICT tools before establishing collaboration helps them measure partner-related criteria before collaborating on a project. A practical DSS could help decision-makers identify potential partners by measuring partner-related criteria.

3 Methodology

This section presents an overview of the research methodology related to this research project. The proposed research design consists of five main phases as shown in Figure 1.

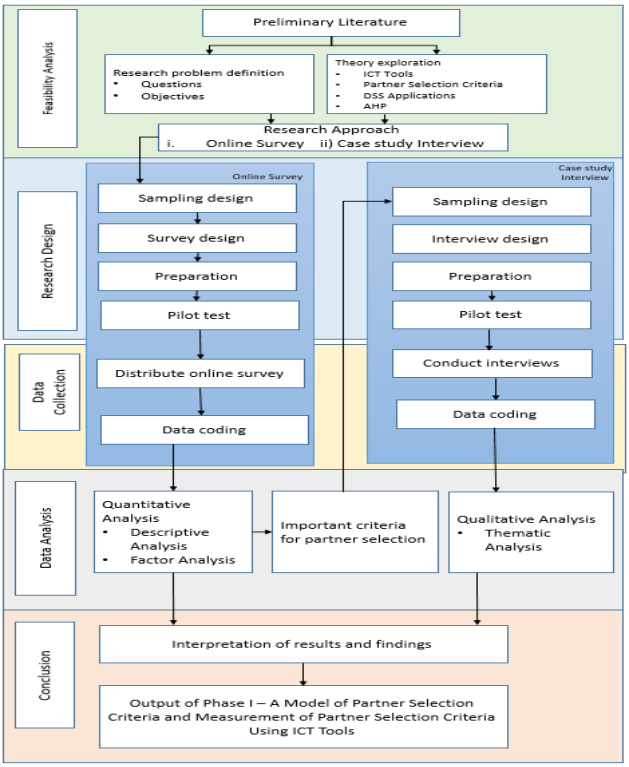

Figure 1: Research Methodology

Phase I consist of Feasibility Analysis, Research Design, Data Collection, Data Analysis, and Conclusion. As depicted in Figure 1, Phase I begins with a literature review to answer the first research question of this study. Several scholarly journals and conference proceedings were analyzed to determine the partner selection criteria used in previous collaboration projects. In addition, the concepts of collaborative networks framework and ICT collaboration tools were investigated to establish a relationship between the partner selection process and criteria and these concepts. To identify partner selection criteria, collaborative network frameworks, ICT tools for collaboration, and DSS concepts, a comprehensive literature review from 1967 to 2021 was conducted to identify all articles pertaining to this study. In the research design sub-phase for the online survey, there are four primary activities: sampling design, survey design, preparation, and pilot testing. The activities in this subphase must be carried out methodically to ensure that the survey's content is relevant and appropriate for the research project. The subphase of data collection consists of two

primary activities for the distribution of an online survey, followed by activities for data coding. The collected data are analyzed to obtain meaningful information: descriptive and factor analysis. The study reveals the essential criteria for selecting a partner. The findings will then be incorporated into the development of the interview questionnaire.

Then, during the subphase of research design and data collection, the input will undergo the same activities as an online survey. The collected interview is analyzed using thematic analysis during data analysis. The findings of the interview are interpreted and used as input for Phase II in the subphase conclusion. The results from both the online survey and the interview will be analyzed in the Conclusion subphase. A model for partner selection and a measurement of partner selection criteria using ICT tools are two outcomes of this subphase.

4 Results and Findings

Several criteria were identified in the literature review; however, the results of the online survey indicate that only a few criteria are significantly required prior to establishing a collaborative relationship. These criteria included trust, commitment, integrity, the ability to negotiate with the local government, knowledge of the host and local market, reputation, and management experience and attitude. Interviews with decision-makers were conducted to gain a comprehensive understanding of the criteria. After conducting the interviews, however, only five criteria could be measured using ICT tools, namely trust, commitment, integrity, reputation, and management experience and attitude.

This study identified the two information sources that can be used to simultaneously measure or evaluate the five essential criteria. As a result, an organization's management can rapidly establish a network of collaboration by utilizing guidelines or standards to measure specific criteria. The findings contribute to aiding organizations in reducing the time required to identify suitable collaboration partners. The use of ICT tools to connect business partners and customers has been identified as a means of conducting business electronically (Dávideková & Hvorecký, 2017; Enrique et al., 2018). The proliferation of ICT as a new means of conducting business may necessitate and necessitate advanced methods of collaboration that may introduce novel interdependencies among partners Beckett & Jones, 2012; Katri Nykänen et al., 2009). According to the opinions of decision-makers, there are a number of comparable ICT-based evaluation tools that can be applied to multiple criteria. "Share mission, location, contact information, and services offered by organizations on their websites" is one example of an evaluation metric that can be used to evaluate all five criteria. As a result, this mechanism expedites the process of self-evaluation because these measurements can also be applied to other criteria. On the basis of the findings from the interviews, thirty-two questions that can be used to evaluate the criteria using ICT tools have been identified, and several measurements are shared among the criteria. Figure 2 depicts the partner selection model, which is derived from activities listed in Figure 1.

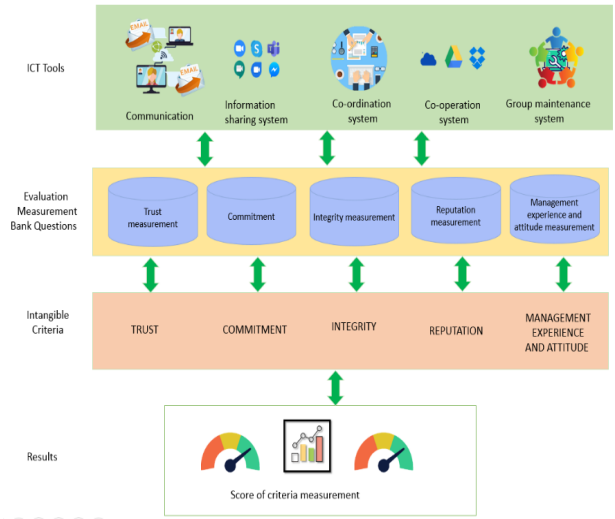

Figure 2: Partner Selection Model

The model then was evaluated by experts was calculated using the PCM formula, as proposed by Tuckman and Waheed (1981):

$$\frac{\text{Total expert score (x)}}{\text{Total maximum score}} \times 100 = \text{Content Validity Level}$$

The expert's score is the result of a questionnaire scale calculation. Experts' total ranking is divided by the overall average. An 8-point scale is used with a maximum score of 5 per item. The maximum score is determined according to the sum of the maximum score number of products. Then the value will be timed. As a consequence, these values are referred to as framework content validity measurements. Table 3 shows the reliability and validity tests conducted to check consistency and verify the measurement of the instrument.

Table 3: Cronbach's alpha values

Criteria (measurement)	Cronbach's alpha
Trust	0.770
Commitment	0.704
Integrity	0.713
Reputation	0.724
Management experience and attitude	0.729

The results of the reliability test show that no items are deleted as all Cronbach alpha is above 0.7. These criteria were then given to several decision-makers in industries to get their opinions regarding the criteria measurement and to identify a possible mechanism to evaluate the criteria using ICT tools. These measurements then were stored in a database that will be used in the process of self-evaluation. The score of each criterion will be calculated based on the answer given by users and will be displayed to them. The process of calculating the weightage or prioritizing each criterion is based on the Analytic Hierarchy Process (AHP). Expert validation was conducted to determine the model's usability at an acceptable rate. Expert validation was done by having experts review the initial draft. The improved draft was then evaluated to ensure that the model is suitable for the target population. The validity process requires at least three experts to perform the validation check (Rubio et al., 2003). This research employed ten experts on content validity and suitability. The selection of experts was based on their theoretical and practical experience in decision-making in organizations at the international and local level., a scale rating was used to determine the quality of the questionnaire. The validity of the model was determined using Tuckman and Waheed (1981), known as the Percentage Calculation Method (PCM), and the validity is good if the value reaches 70 percent. Table 4 shows content validity measurement for the model. The achievement of content validity is measured using the PCM process.

Table 4: Percentage Calculation Method for Partner Selection Model

	EXPERT									
ITEM	1	2	3	4	5	6	7	8	9	10
1	3	3	4	4	2	3	4	3	4	4
2	3	2	3	4	4	3	3	2	3	3
3	3	2	3	3	3	3	3	3	3	3
4	3	3	4	4	4	3	4	4	3	3
5	3	3	4	3	2	4	4	2	4	3
6	3	3	4	4	4	4	4	4	4	3
7	4	2	4	3	4	4	3	2	4	3
8	4	4	4	3	3	4	4	4	4	3
9	4	3	4	3	3	4	4	4	4	3
10	3	3	4	3	2	4	4	2	3	3
11	4	3	4	3	3	4	4	4	3	3
12	4	3	4	3	4	4	3	4	4	4
13	3	3	4	4	3	4	4	3	4	3
14	4	4	4	2	3	4	4	3	4	3
15	4	4	4	3	3	3	4	3	3	4

16	4	4	4	3	3	3	4	3	4	4
TOTAL	56	49	62	52	50	58	60	50	58	62
Content Validity Achievement (100%)										87.03
Content Validity Coefficients (1.00)										0.87

As shown in the table, the model has achieved the content validity of 87.03 % with a coefficient value of 0.87 and the value is above 70% or 0.70. Based on the result, the validity of the contents in the model is considered to be good.

5 Discussions

This research contributes in terms of identifying the important criteria for selecting partners in collaborative networks. In addition, this study also shows the importance of focusing on particular criteria at the early stage of establishing collaboration to avoid unsuccessful collaboration. The partner-related criteria are defined as those which are mainly related to the behavioral aspects of working life such as culture, trust, leadership, human resource management and commitment. It is usually challenging to assign a numerical value to these, and as such, these criteria are more freely interpreted. Several measurements have been identified to evaluate the trust, commitment, integrity, reputation, and management experience criteria by integrating the given measurements with ICT tools.

Another contribution of the study is the integration of ICT in the partner selection process for collaboration. ICT should be considered an important part of the infrastructure that helps organizations to find information regarding their potential partners and consequently reduces the time and effort taken by organizations in selecting potential partners. Organizations could optimize their time in the partner selection process, as the sources for evaluating the five criteria for partner selection were shared among organizations across all levels of inter-organizational relationships. One possible solution to help organizations gather all the information needed is to transform Internet resources (such as information about competitors, employees, clients or potential markets) into knowledge for business success. Consequently, ICT is one of the possible solutions to obtain and disseminate the information required to evaluate potential partners. ICT applications such as social media or Web 2.0 are among the applications that organizations can use to obtain the necessary information. In other words, organizations could use information technology capabilities and emerging technology to collect the required information via the Internet effectively. For example, this can be done by integrating social media as a component of a long-term strategy (Baptista et al., 2017; Fink et al., 2020). Social media attracts hundreds of millions of users and can be used to communicate with employees, competitors, customers or clients for various purposes. This study identified the two sources of information that can be used to measure or evaluate the five important criteria concurrently. As a result, an organization's management can rapidly create a collaborative network as they can use guidelines or standards to measure particular criteria. The find-

ings contribute to helping organizations reduce their time in finding the right partners to collaborate with them. The study also identified several possible ICT tools that can be used to help organizations to get information about the partner selection criteria. Consequently, if an organization starts thinking about collaborating with other organization, then they could rely on ICT to get information about the trust, commitment, integrity, previous track record of their potential partners and management experience and attitude.

Organizations should consider the listed mechanisms such as the partner profile, previous performance, or reviews from other organizations in selecting the partners and emphasize these criteria in selecting partners for collaborative networks. It is hoped that the fourteen listed mechanisms identified in this study through the interviews can be used to reduce the time spent by organizations in the partner selection process. The study also shows the importance of preparing a profile of partners as it can be used to evaluate most of the important criteria identified in this study. All the information on a potential partner can be aggregated to form the profile of the partner. The availability of a company profile that compiles all the comprehensive information on an organization can be used as a prerequisite document that needs to be submitted before participating in collaborative networks. It can be used for evaluating trustworthiness, commitment, integrity, management experience and attitude, and track record in business. This finding on the importance of competence profiling corroborates the previous research that suggests the need for companies to exchange a standard competence profile in the business process. Moreover, the finding supports a previous study that explains that competence profiling can be used to identify skills, knowledge, attitudes and behavior in accomplishing a task.

This study has identified the sources of information that can be used to evaluate the listed criteria. These sources could be used to evaluate the five main partner selection criteria of trust, commitment, integrity, management experience and attitude, and reputation. The findings of this study have several significant implications for partner selection for collaborative networks.

6 Conclusion

This study develops a generic model for partner selection by integrating ICT tools. The main purpose of this model is to help organizations in selecting partners by considering the partner-related criteria. The model consists of four phases and in the next research, this model will be supported by DSS to suit to any kind of collaboration project. The criteria employed in the model are general criteria that are significantly required by all types of collaboration projects, especially for the collaborative network. The criteria were embedded as one of the phases in the model. One of the exciting features of the model is the partner-related criteria selection model which plays an important to decision-makers. This model guides decision-makers in conducting the decision-making process by providing a performance score of each criterion for a potential partner. Next, a framework provides a guideline for developers in designing and developing a DSS in the future.

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