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# **Proposed Information Exchange Decision Support (IEDS) Framework**

*Completed Research*

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## **Abstract**

Information Exchange (IE) is an important area of research in Information Systems (IS), there is a lack of a framework that guides the design of an IE systems to support IE among multiple stakeholders with the purpose of improving the decision-making. To address this literature gap, this paper utilizes the Theory of Information Exchange (ToIE) as a kernel theory to develop an Information Exchange Decision Support (IEDS) framework. The framework depicts how to design an IE platform for multiple stakeholders to improve their decision quality. The qualitative evaluation shows that the IEDS framework is useful for identifying stakeholders, specifying information to be exchanged, and maintaining motivation factors necessary for IE. The IEDS framework offers prescriptive knowledge for building an effective IE in a multiple stakeholder environment and it can be applied in different business domains and provide guidance to the designers and developers of IE platforms.

## **Keywords**

Information Exchange, Theory of Information Exchange, Decision support, Decision making, multi-stakeholders, System Design.

## **Introduction**

The topic of Information Exchange (IE) has been given a lot of attention in the literature (Lenert & McSwain, 2020; Tang et al., 2020; Rivard et al., 2019; Lin & Chang, 2018). It has been addressed not only from the business side to improve communication within an organization (Moberg et al. 2002; Naslund & Williamson 2010; Nicolaou et al. 2013) , but also from the social side to build a better community (Hajli & Lin 2016; Hall et al. 2010; Zheng et al. 2013; Xiao et al. 2012; Lin & Chang 2018; Serenko & Bontis 2016). However, the literature shows that there are still challenges related to exchanging information among different stakeholders, where a stakeholder is an individual or an organization that has an interest in activities or outcomes of the IE (Cleland 1985 as cited by McGrath & Whitty 2017; Pouloudi & Whitley 1997). These challenges include but are not limited to, identifying different information needs (Dennis, 1996; Cress et al., 2006) for different stakeholders, and designing a communication platform for information flow (Rivard et al., 2019; Ko & Chang, 2018).

Existing IE literature mainly focuses on issues in domains such as supply chain (Moberg et al., 2002; Naslund & Williamson, 2010; Nicolaou et al. 2013), employees' knowledge sharing (Lin & Chang, 2018; Cress et al., 2006), and health information exchange (Lenert & McSwain, 2020; Lin & Chang, 2018; Rivard et al., 2019; Ko & Chang, 2018), where IE is either within the same organization or between relevant organizations to improve profit or business performance. Additionally, most of IS research in IE is limited to investigating the impact of IE on the relevant stakeholders who directly interact with each other in a business domain. There is a lack of research about how to design IE system to facilitate IE among multiple indirectly related stakeholders, some of whom may not have direct interactions.

The research question that this study seeks to answer is: “How to design a robust IE system that improves the decision-making quality among multiple stakeholders?”. Within the context of multiple stakeholders, Information Exchange defined as “the acquisition and sharing of information among two or more stakeholders to improve decision quality”(Bazarah and Li 2020). The ToIE depicts how multi-stakeholders can be motivated to exchange their unique information, and how exchanged information can be aggregated to represent common information that can improve the decision quality of each stakeholder. Thus, this research will utilize ToIE as a kernel theory to answer the research question. More specifically, an Information Exchange and Decision Support (IEDS) framework is proposed as a blueprint to guide the design of IE platforms that would facilitate IE among multiple stakeholders to improve decision-making instead of a narrow focus on improving business profit or performance. To the best of our knowledge, this is the first IEDS framework that guides building information exchange systems to improve the decision-making of multiple stakeholders.

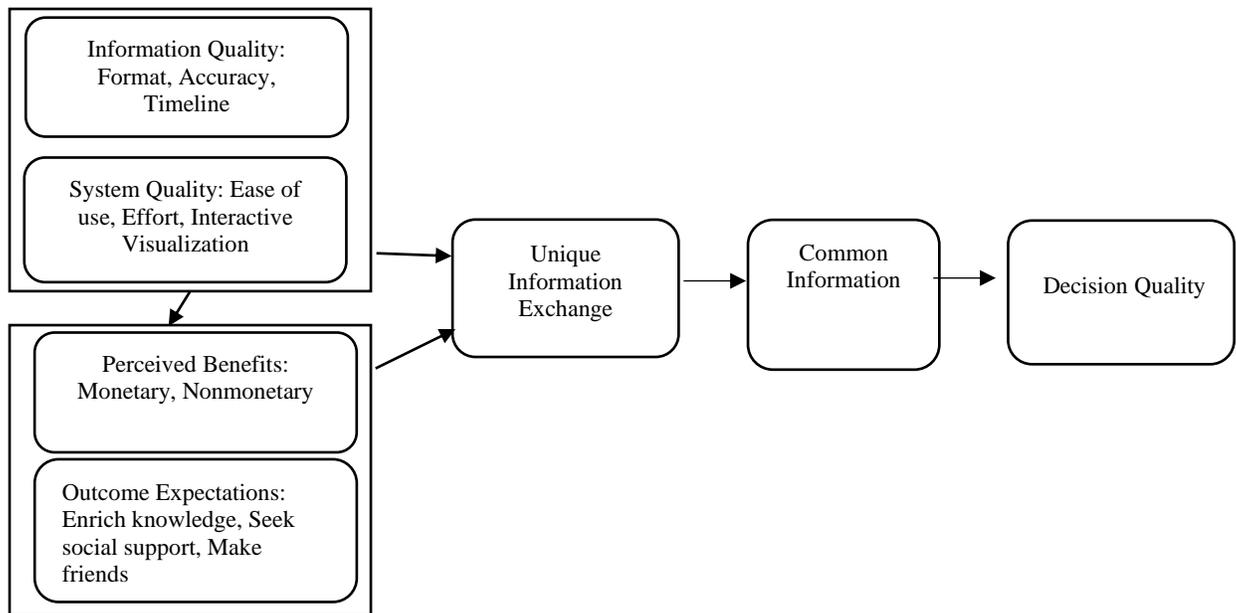
The rest of the paper is organized as follows. We first describe the ToIE and research methodology, and then present the proposed IEDS framework and its evaluation. We then conclude the paper and highlight research contributions.

## Theory of Information Exchange

The theory of information exchange (ToIE) for multiple stakeholders is stated as “*when some stakeholders share their unique information, other stakeholders will share their information, which will build common information that would improve the decision-making process of every stakeholder involved*” (Bazarah and Li 2020).

As depicted in *Figure 1*, ToIE identifies four motivational factors, i.e., information quality, system quality, perceived benefits, and outcome expectations, that encourage stakeholders to exchange their unique information. Information quality can be defined in terms of information format, accuracy, and timeline (Moberg et al. 2002). System quality means the ease of use and the time and effort required to use the system and engage with the content (Hilmer And Dennis 2000). Perceived benefits and clear outcome expectations are major determinants of the continuance of use of IE (Lin & Chang, 2018; Homburg, 2000; Hall et al., 2010; Xiao et al., 2012; Zheng et al., 2013; Cress, Kimmerle, & Hesse, 2006). Perceived benefits are the expected gain that individuals hope to get from a specific interaction (Zheng et al. 2013). Outcome expectation is the anticipated value or the expected consequences of individual behaviors (Lin & Chang, 2018; Xiao et al., 2012).

The ToIE posits that with these motivation factors, the stakeholders would be motivated to share their unique information, which is information known to one stakeholder but not to others (Dennis et al.,1998), or partially shared information, which is known to some members but not all (Dennis et al.,1998) The exchanged unique information can then be aggregated as “common information”, which is the information shared among and accessed by all stakeholders (Dennis et al.,1998). More unique information would lead to more common information being exchanged. The decision that has been made while considering comprehensive information from different perspectives will have much better quality than the decision that considers only limited information (Dennis, 1996). Thus, more common information would lead to better decision quality for different stakeholders.



**Figure 1. Theory of Information Exchange (ToIE)** (Bazarah and Li 2020)

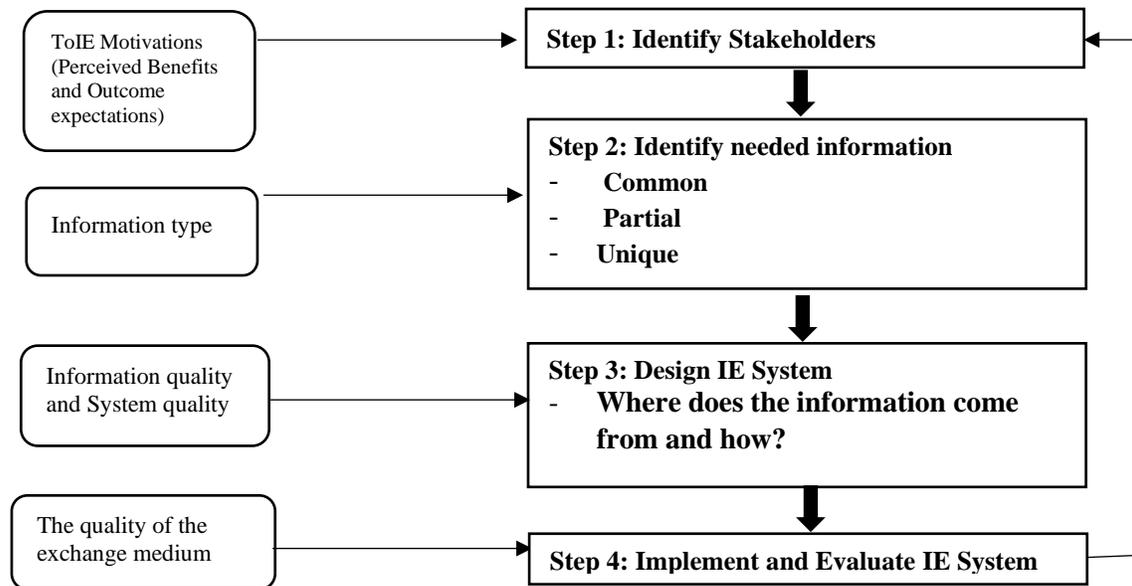
## Methodology:

This research uses design science research (DSR) methodology (Chatterjee and Hevner 2010) by building artifacts to solve the problems related to information exchange among multiple stakeholders to increase decision quality. DSR starts with identifying the problem, designs and builds a solution, evaluates the outcome, and then seeks possible improvements. Through the iterative process of building and evaluating the artifacts, DSR highlights the rigor and relevance cycles. The rigor cycle demonstrates that the method of developing and applying the solutions is based on the existing foundation and the knowledge base in the field. The relevance cycle highlights applying the resulting solution to the business, organizational, or societal need in a relevant environment (Hevner et al. 2004).

The artifact of this research is an Information Exchange Decision Support (IEDS) framework. The framework design demonstrates its rigor by following the guidelines of DSR (Hevner et al. 2004) and the DSR model of Peffers et al. (2007) and using ToIE as its kernel theory. The IEDS framework is evaluated by instantiating it to an IE system that facilitates information exchange among three different types of stakeholders (i.e., scholarship organizations or sponsors, employers, and students). The Framework is further evaluated through semi-structured interviews and focus groups.

## IEDS Framework

As described earlier, ToIE is the kernel theory for the design of IEDS framework. Thus, the IEDS framework should meet the three assumptions of the ToIE: (1) IE is among multiple stakeholders interested in participating in Information Exchange, (2) each stakeholder has their unique information to be exchanged, and (3) all stakeholders use an IE system to access the common information. To satisfy the first assumption, the IEDS framework should include the identification of the stakeholders who want to participate in IE. For the second assumption, the framework should provide functionalities to elicit unique information from different stakeholders. For the last assumption, the IEDS should provide guidelines for designing a system for effective IE and improved decision quality. Based on these requirements, the proposed IEDS framework includes 4 steps as shown in *Figure 2*. Because the purpose of IEDS is to improve the decision quality of different stakeholders and is not limited to increasing the business value or profit, we use a case of humanitarian assistance to illustrate how to carry out each step in the following sections.



**Figure 2. Information Exchange Decision Support Framework (IEDS)**

### **Step 1: Identify Stakeholders**

The first step in the IEDS framework is to identify stakeholders who would participate in IE. Each stakeholder should hold unique information that is valued by other participating stakeholders. Stakeholders may be defined differently based on different perspectives. For example, the business dictionary defines “stakeholder” as “A person, group or organization that has interest or concern in an organization” (“Stakeholder Definition” n.d.). From a business perspective, Freeman (1984) defined stakeholders as “anything influencing or influenced by the firm” to include suppliers, employees, customers, governments, and competitors”, whereas Cleland (1985) defined a “stakeholder” as any person or organization that has an interest in the outcome of a project. These definitions highlight three main characteristics of stakeholders as being interested in a group or work, having an effect or being effected by a group, or a combination of both (McGrath & Whitty, 2017).

These definitions themselves do not provide a concrete way for identifying stakeholders for a specific project (Sharp et al. 1999; Pouloudi and Whitley 1997). Several practical approaches to identify stakeholders have been proposed in the literature. One is to identify stakeholders based on four principles: (1) the contingency of the context of stakeholders; (2) inter-relations among stakeholders; (3) the possible change over time; and (4) the political issues that underpin each stakeholder (Pouloudi and Whitley 1997). Another approach is to choose stakeholders based on their roles or the expected work that is supposed to be done rather than choosing specific people (Sharp et al. 1999). A recent approach, “stakeholder analysis”, builds on a social network of recommendations - when one stakeholder is identified, he or she will recommend the next stakeholder and so on (Lim et al. 2011). All these practical approaches can be used to identify stakeholders.

By building on the ToIE, when one of the identified stakeholders share its unique information, the other participating stakeholders will feel obligated to share their unique information as well. Two ToIE motivation factors are relevant in identifying stakeholders: perceived benefits and outcome expectations. For stakeholders to participate in the IE, they need to have a common interest that allows them to maximize their benefits and get some reward. Because all the identified stakeholders have a direct interest, have an impact, or will be impacted by the success of the project at hand, perceived benefits and outcome expectations will motivate them to participate in the IE to ensure the overall success of the project.

In the case of humanitarian assistance, the stakeholders would include humanitarian organizations that distribute aid, the government of countries with humanitarian crises, and the affected population in these countries. Those stakeholders are identified based on their interest in the project, their direct effect on the project, or the consequences of the project on their regular work. Examples of the perceived benefits and outcome expectations include organizing the work between humanitarian organizations, removing work

duplications, reducing the pressure on the government, reducing the overhead, and better serving the community.

### ***Step 2: Identify Needed Information***

After identifying stakeholders who have a common interest in IE, it is important to satisfy the second ToIE assumption, which is to identify the needed information that is required for IE. Based on the information status, information can be classified into three categories: common information, unique information, and partially shared information (Dennis et al. 1998). For successful IE, participating stakeholders need to share or exchange their unique information, not prevalent information that is already known to everyone. In this step, the identified stakeholders need to decide on what information they need as “common information” for optimal decision making, and what each stakeholder can contribute its “unique information” or “partial information” to reach the “common information”. Therefore, the IE system should provide functionalities for each stakeholder to share their unique information, and then aggregate this unique information as “common information” that allow stakeholders to have a comprehensive view of new and relevant information that is not known to them before, which they can use for their decision making. The “common information” needs to be revisited and evaluated from time to time because the stakeholders’ need may change over time.

Going back to the illustrated case, the “common information” could include demographic information, economic status, and health information of the affected population, aids that are already distributed, and what different kinds of aids are needed. The next step is to decide where the common information will come from. That is, how each stakeholder may provide their unique information to reach the common information. For instance, the government can provide demographic and health information of the affected population; humanitarian organizations can provide information about the work they have already done, and the affected population can provide information about what they need.

### ***Step 3: Design IE System***

This step starts designing the IE system that allows each stakeholder to share its unique information and represent the common information. This step is concerned about where the information will come from and how. A key task in this step is to determine what systems, technologies, and tools would be used to build the IE system so that different stakeholders can exchange their unique information easily and seamlessly. Different technological options should be evaluated. According to ToIE, the chosen technologies need to ensure two motivation factors: information quality, such as information format, accuracy, and sequence (Moberg et al. 2002); and system quality, such as ease of use, required time and effort (Hilmer & Dennis 2000), and interactive visualization (Hilmer And Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012) such as navigation, filtering, or selection (Conati et al. 2014).

Returning to the humanitarian assistant example, each stakeholder will use an information entry page to contribute their unique information. The system will then aggregate the information as common information and present it effectively to different stakeholders. To improve decision quality, the system should present the information in a user-friendly format; should be easy to use with no extra effort required to share or engage with content; and should visualize the information clearly and compellingly (Miller et al. 2012).

### ***Step 4: Implement and Evaluate IE System***

The final step is the implementation of the IE system based on design requirements identified previously, especially for these factors that would motivate participants to exchange their unique information. The information quality and system quality need to be satisfied because the overall success of the IE behavior will depend on these two motivation factors. If there is a discrepancy in the information format or if there are extra efforts required by users to interact with the system, the IE will not be successful (Moberg et al. 2002; Hilmer And Dennis 2000).

It is important to highlight that these steps of the IEDS framework are iterative, meaning that after implementing and using the IE system, the system designers may need to go back to the first step and check the participants’ common interest and the value of the shared information, evaluate the impact of the

common information on the decision-making process, address whether the system facilitates the flow of the information or not, and then make the required adjustments to the system to ensure that the system provides continuous support in improving decision quality.

Referring back to the humanitarian example, if all stakeholders are committed to exchange their unique information using the IE system, then the system will present the common information that satisfies all the participating stakeholders and improve their decision quality. For example, the humanitarian organizations may use the system to decide on where to provide their subsidies, prevent conflict or duplication with other organizations, and anticipate how much aid may be needed for the affected population. The government may keep track of the need of its people and organize work among different humanitarian organizations. Finally, the affected population may reach specific organizations based on their needs. All these decisions would not be possible without the IE system.

In the next section, the IEDS framework is evaluated using a case of an educational system that has three types of stakeholders who are interested in information exchange to make decisions. An IE system was developed to evaluate the effectiveness of the framework.

## Designing an Educational IE System Using IEDS Framework

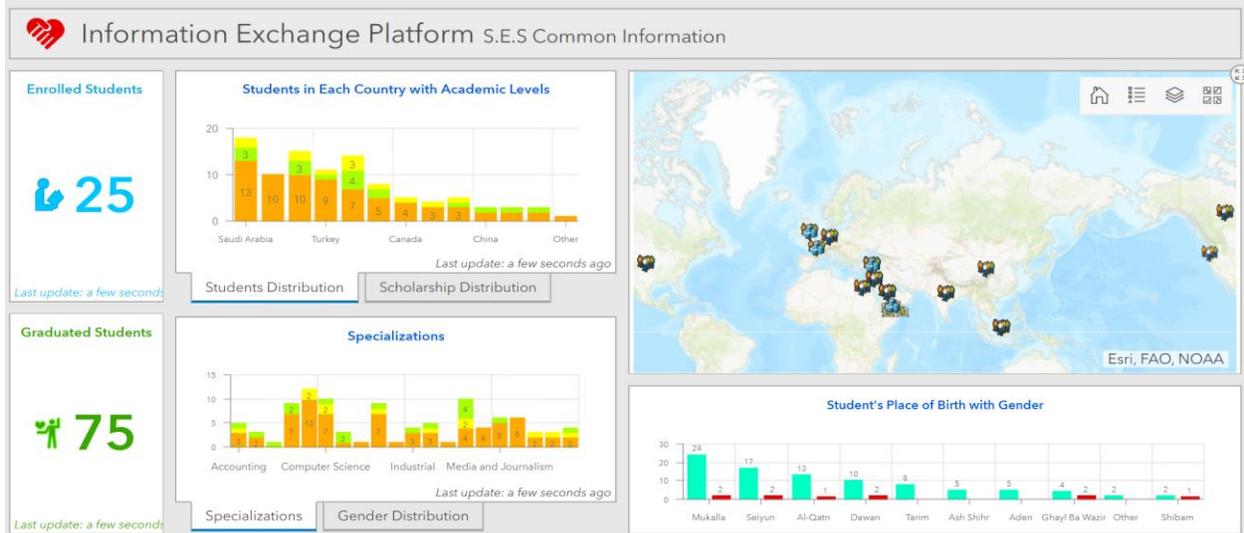
The case study attempted to solve a problem related to the education system and its linkage to market needs in a middle-east country, where different stakeholders (e.g., scholarship organizations, employers, and students) could not make optimal decisions based on their own unique information. With the assumption that each stakeholder may have unique information that other stakeholders need to improve their decision quality, the IEDS framework is used to design an IE system for Scholarship organizations, Employers, and Students (SES).



**Figure 3. The SES-IE System Main Interface**

Following the first step of IEDS, all stakeholders along with their perceived benefits and outcome expectation of participating in the IE were identified. Each of the SES stakeholder groups had expressed their interest in the IE, and each knew exactly the benefits and the expected outcomes of participation in this IE. For the second step, a focus group discussion was conducted with highly knowledgeable representatives in leading positions from different stakeholder groups, where the needed information was identified, including common information, partial information, and unique information. In the following third step, Esri's ArcGIS Insights, Dashboards, and Survey123 tools were selected as technologies to provide the necessary features and functions and ensure information quality and system quality factors as specified in the IEDS. In the last step, the SES-IE platform was implemented using the selected technologies. More specifically, Survey123 was used for capturing each stakeholder's unique information, where each stakeholder would enter information through a unique web form. ArcMap was used to aggregate all the exchanged information and display it on a map. Additionally, ArcGIS insights and dashboards were used to

visualize the aggregated common information. Finally, StoryMaps and web builder were used to build the system. As a successful instantiation of the IEDS framework, the SES-IE showed the applicability of the IEDS framework, while the framework's effectiveness is evaluated in the next section.



**Figure 4. SES-IE Common Information Representation**

## IEDS Framework Evaluation

Using a snowball sampling approach, several semi-structured interviews and focus groups were conducted. The participants included 40 highly knowledgeable adults (18-65 years old) in leading positions from different stakeholder groups: nine from scholarship organizations (including CEO, Board member, founders), four as employers, and 27 graduate students. Table 1 below summarizes the number of participants in interviews and focus groups.

| Stakeholder               | # of Interviews          | # of Focus Groups            |
|---------------------------|--------------------------|------------------------------|
| Scholarship organizations | 5                        | 1 (total of 4 participants)  |
| Employers                 | 4                        | 0                            |
| Students                  | 1                        | 6 (total of 26 participants) |
| Total                     | Total of 10 participants | Total of 30 participants     |

**Table 1. The Number of Participants in Interviews and Focus Groups**

Each interview took about one hour. All interviews were recorded and transcribed. The interview began by illustrating the research problem and the importance of IE in improving decision quality. Then, the IEDS framework (see figure 2) was presented to the participants, and explanations were given about how stakeholders and needed information were identified, and why certain technologies were chosen. This was followed by a live demo of the SES-IE system, showing its ability to exchange information among participating stakeholders for decision-making. During the demo, ToIE factors considered in the system design were communicated with the participants. The interview ended with open-ended questions, focusing on the usefulness of the framework and the system, especially related to the participants' decision quality.

All participants liked the systematic approach of building the SES-IE system, especially the comprehensiveness of the framework that covers all relevant parts of their decision-making process. A scholarship organization CEO said:

*The motivation for stakeholders to exchange their information is very critical to the success of the system. We have implemented a similar system between different*

*organizations, but we failed because of the lack of commitment of these organizations to exchange their information. I believe the framework accounts for the shortcomings that we did not consider in building our system.*

Participants also highlighted the importance of expected outcomes and perceived benefits factors of the IEDS framework. When participants were asked about their expected outcomes and the perceived benefits from using the IE system, the common answer across all stakeholders was improving the decision-making process by having access to common information. Then participants provided more details about their expectations and perceived benefits including both the monetary and nonmonetary aspects. For example, reducing costs and saving resources were among these monetary perceived benefits. As one scholarship CEO said:

*By bringing together different scholarship organizations, not only we can improve the scholarship program outcomes but also save many resources and plan better for the future. Instead of planning the scholarship program based on internal information of each organization as it is currently done, the platform will provide a paradigm shift by considering information from different organizations' information.*

One expected outcome was social justice. Scholarship organizations mentioned that the system would allow them to investigate the gender differences among the sponsored students in different cities. Social connection is another expected outcome mentioned by students, as shown in the quote below:

*If I have been offered a scholarship to a specific country, I can easily see whether there are [scholarship] students in that country or in the university that I am going to.*

The participants especially commented on the interactive visualization of aggregated common information because it reduced their effort to search particular information and also allowed them to comprehend the information more easily for their decision making. This confirms with the literature that interactive visualization was an important system quality factor. Additionally, the system quality and information quality were considered high by participants for their simplicity and ease of use such as user-friendly format, and easy filtering and navigating from summary information to detailed information.

One concern raised by many stakeholders was information accuracy. Their concern was that if one stakeholder shared inaccurate information, how would the system or the framework account for it? Such a concern could be addressed from two perspectives. First, the IEDS framework specifies that stakeholders are selected based on the role that they play in IE and their interest in the project outcomes. If the stakeholders are carefully selected with a real interest in IE, they will most likely share accurate information, because the impact of sharing inaccurate information would negatively affect all stakeholders including themselves. Second, while validating the accuracy of the shared information is beyond the scope of this research, future research may investigate how to verify the quality of shared information as a component of the IEDS framework.

The evaluation confirms that the IEDS framework is very effective in guiding the design of the IE system to improve the decision quality of multiple stakeholders. It shows the importance of the system quality and information quality factors in designing an IE system, as highlighted in the IEDS framework. Finally, the evaluation highlights the importance of understanding perceived benefits and outcome expectations when identifying relevant stakeholders. If these two factors are not well addressed during the design of the IE system, it will negatively impact the continuance use of the platform (Lin & Chang, 2018; Homburg, 2000; Hall et al., 2010; Xiao et al., 2012; Zheng et al., 2013; Cress et al., 2006).

## **Conclusion**

In this research, we propose an IEDS framework that provides a step-by-step process for guiding the design of an information exchange (IE) system between different stakeholders to improve the decision quality of each stakeholder. Based on the kernel theory of ToIE, the framework highlights important factors in creating an effective IE system, including perceived benefits, outcome expectations, information quality, and system quality. An IE system was instantiated based on the framework and the qualitative evaluation with participating stakeholders showed the effectiveness of the framework.

This research has both theoretical and practical contributions. For the theoretical contribution, it offers prescriptive knowledge for building an effective IE to facilitate information exchange and the decision-making process in a multiple stakeholder environment. Such a theoretical contribution naturally leads to its practical contribution, where the IEDS framework can be applied in different business domains and provide guidance to the designers and developers of IE platforms.

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