Information Exchange (IE) Among Multi-Stakeholders for Improving Decision Making

Ali Mohammed Salem Bazarah

Claremont Graduate University

Follow this and additional works at: https://scholarship.claremont.edu/cgu_etd

Recommended Citation

This Open Access Dissertation is brought to you for free and open access by the CGU Student Scholarship at Scholarship @ Claremont. It has been accepted for inclusion in CGU Theses & Dissertations by an authorized administrator of Scholarship @ Claremont. For more information, please contact scholarship@claremont.edu.
Information Exchange (IE) Among Multi-Stakeholders for Improving Decision Making

by
Ali Mohammed Salem Bazarah

Claremont Graduate University
2021

© Copyright Ali Bazarah, 2021
All rights reserved
APPROVAL OF THE DISSERTATION COMMITTEE

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Ali Mohammed Salem Bazarah as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy (Ph.D.) in Information Systems and Technology.

Yan Li, Chair
Claremont Graduate University
Professor

Lorne Olfman, Member
Claremont Graduate University
Professor

Brian Hilton, Member
Claremont Graduate University
Professor
Abstract

Information Exchange (IE) Among Multi-Stakeholders for Improving Decision Making

By

Ali Mohammed Salem Bazarah

Claremont Graduate University: 2021

Information Exchange (IE) is an important area of research in Information System (IS), yet there is a lack of theory that explains it. Existing studies usually borrow different theories from other fields to explain IE, but these theories describe the aspects that are associated with IE, not the actual behavior of IE. Additionally, a framework that guides the design of an IE platform to support IE among multiple stakeholders with the purpose of improving the decision-making process does not exist. To address these literature gaps, this dissertation first proposes a theory of Information Exchange (ToIE) to explain IE behavior and its impact on the decision-making process among multi-stakeholders. A qualitative evaluation of ToIE demonstrates that it meets the virtues of a good theory. Second, this dissertation develops an Information Exchange Decision Support (IEDS) framework that can guide the design of IE platforms for multiple stakeholders. The qualitative evaluation shows that the IEDS framework is useful for identifying the stakeholders, specifying the needed information to be exchanged, and maintaining the needed system factors necessary for IE. The IEDS framework is further instantiated to an IE platform named SES-IE. The SES-IE platform is a web-based application that facilitates the information exchange among scholarship organizations, employers, and students, and supports their decision-
making process. The SES-IE platform was evaluated using a mixed-methods approach to measure the usability, usefulness, and satisfaction of the system. The successful instantiation of the SES-IE platform shows that the IEDS framework is useful for building an effective IE platform. This dissertation makes theoretical and practical contributions.
Dedication

I dedicate my dissertation work to my beloved family who have meant and continue to mean so much to me and supported me during my journey. A special feeling of gratitude to my parents Mohammed Salem Bazarah and Shifaa Omar Banajah who always shower me with their prayers and were a great source of support. To my wife Arwa Anwar Ba-Abbad for her kindness and devotion, who has never left my side and shares all the struggles I went through to accomplish this work. To my kids, Mohammed and Shafaa, and the little boy Ashraf who is always a source of enjoyment: your presence is very special.
Acknowledgement

My journey at CGU has been very rewarding and fulfilling. It has helped me to strengthen my technical, teaching, and research skills, and has enriched my knowledge about applying these acquainted skills to solve a real-world problem and make a significant contribution. This dissertation is a result of everything I've learned and experienced during my journey. For that, I would like to thank everyone who has helped me especially my professors and my fellow students.

Most importantly, I would like to express my deepest and sincere gratitude to my dissertation chair, Dr. Yan Li, for her tremendous support. During my dissertation, she has overseen my work by giving suggestions and insights, providing revisions for my writing and shaping my work, and providing guidance and commitment to complete this dissertation. I will be forever thankful to you.

I am also tremendously thankful to Dr. Lorne Olfman for his guidance and advice during my coursework and dissertation. I had the privilege to be his teaching assistant in which he has enriched my teaching skills and my knowledge about research principles and methods. I am grateful that he is a member of my dissertation committee and thankful for his comments and edits in my dissertation document.

I am also grateful to Dr. Brian Hilton for his support and help during my coursework and dissertation. He has helped me to enrich my knowledge and skills of using GIS to solve location analysis problems. I am very honored to have been his teaching assistant for the GIS course for two consecutive years, during which I learned a lot and gained the ability to apply and practice what I have learned. I am very fortunate that he is a member of my dissertation committee.
I am also tremendously grateful to the Hadramout Establishment for Human Development (HEHD) for their financial support and their sponsorship for pursuing my Ph.D. I give special thanks to Eng. Abdulla Bugshan who was a great source of inspiration and provides me endless and limitless support financially and emotionally. I also give a special thanks to my dear friend Shane Rose who was a great support to go through the life difficulties I faced during my PhD journey.

Not least of all, I owe so much to my whole family for their undying unconditional support, their unwavering belief that I can achieve so much. Unfortunately, I cannot thank everyone by name, but I just want you all to know that you mean so much to me. Had it not been for your prayers and benedictions, had it not been for your sincere love and help, I would never have completed this Dissertation. So, thank you all.
# Table of Contents

Chapter 1. Introduction ................................................................................................................1

1.1 Research Gaps and the Proposed Solutions ........................................................................4

1.2 Significance of the Research ...............................................................................................5

Chapter 2. Literature Review .....................................................................................................7

2.1 Existing Techniques for IE ..................................................................................................8

2.1.1 Group Support Systems (GSS) .......................................................................................8

2.1.2 Interactive Visualization Techniques .............................................................................11

2.1.3 Integrated System ..........................................................................................................12

2.2 IE Research Areas in IS .....................................................................................................14

2.3 Existing Theories for IE in IS ............................................................................................16

2.3.1 Theory of Social Exchange ..........................................................................................18

2.4 Factors that Motivate IE ...................................................................................................20

Chapter 3. Research Methodology .............................................................................................24

3.1 Proposing a Theory .............................................................................................................25

3.2 Building an IEDS Framework and IE Platform ................................................................26

Chapter 4. A Theory of Information Exchange (ToIE) .............................................................29

4.1 Propositions of ToIE ..........................................................................................................31

4.1.1 Common Information ....................................................................................................31

4.1.2 Unique information Exchange ......................................................................................32
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.3 System Quality and Information Quality</td>
<td>32</td>
</tr>
<tr>
<td>4.1.4 Perceived Benefits and Outcome Expectations</td>
<td>34</td>
</tr>
<tr>
<td>4.2 Evaluation of ToIE</td>
<td>36</td>
</tr>
<tr>
<td>4.2.1 ToIE as a theory</td>
<td>37</td>
</tr>
<tr>
<td>4.2.2 ToIE virtues of a good theory</td>
<td>41</td>
</tr>
<tr>
<td>4.3 Implications of ToIE</td>
<td>44</td>
</tr>
<tr>
<td>Chapter 5. IEDS Framework</td>
<td>46</td>
</tr>
<tr>
<td>Chapter 6. IE Platform Implementation and Evaluation</td>
<td>55</td>
</tr>
<tr>
<td>6.1 The Background of the Case Study</td>
<td>55</td>
</tr>
<tr>
<td>6.2 Steps to Build the SES-IE Platform</td>
<td>57</td>
</tr>
<tr>
<td>Step 1. Identify the Stakeholders</td>
<td>58</td>
</tr>
<tr>
<td>Step 2. Identify the Needed Information</td>
<td>60</td>
</tr>
<tr>
<td>Step 3. Design the IE System for Information Exchange</td>
<td>62</td>
</tr>
<tr>
<td>Step 4. Implement the IE System</td>
<td>65</td>
</tr>
<tr>
<td>6.3 The SES-IE Platform Evaluation</td>
<td>80</td>
</tr>
<tr>
<td>6.3.1 Qualitative Evaluation</td>
<td>80</td>
</tr>
<tr>
<td>6.3.2 Quantitative Evaluation</td>
<td>88</td>
</tr>
<tr>
<td>6.4 IEDS Framework Evaluation</td>
<td>94</td>
</tr>
<tr>
<td>Chapter 7. Conclusion, Limitations, and Future Work</td>
<td>98</td>
</tr>
<tr>
<td>References</td>
<td>103</td>
</tr>
</tbody>
</table>
Appendix A. Questionnaire of Information Exchange Among Multi-Stakeholders for Improving Decision Making ................................................................. 110

Appendix B. Interview Questions of Information Exchange among Multi-Stakeholders for Improving Decision Making ................................................................. 114

Appendix C. Descriptive Results of User Satisfaction across the Roles ........................................ 116

Appendix D. Descriptive Results of Perceived Usefulness across the Roles ................................. 117

Appendix E. System Usability Scale (SUS) Results ................................................................. 118

Appendix F. Map Pop Up Configuration ........................................................................ 119
List of Figures

Figure 1. Categories of IE Motivational Factors (Matschke et al., 2014) ...........................................23

Figure 2. Proposed theory of Information Exchange (ToIE) .................................................................30

Figure 3. Information Exchange Decision Support Framework (IEDS) ....................................................47

Figure 4. System Requirements ..............................................................................................................63

Figure 5. The Flow of the Process ........................................................................................................64

Figure 6. Student IE Form .......................................................................................................................66

Figure 7. Scholarship IE Form .................................................................................................................67

Figure 8. Employer IE Form ....................................................................................................................68

Figure 9. Web Map1 of All Stakeholders ...............................................................................................69

Figure 10. Pop Up Configuration for Countries .......................................................................................70

Figure 11. Pop Up Configuration for Jobs ...............................................................................................71

Figure 12. Pop Up Configuration for Scholarships ..................................................................................71

Figure 13. Web Map2 For Scholarship Organizations and Employers ......................................................72

Figure 14. “Common Information” Dashboard .......................................................................................73

Figure 15. Jobs/Scholarships Vacancies Dashboard ..............................................................................75

Figure 16. Interactive Statistics Page .....................................................................................................76

Figure 17. Web Builder Main Interface ..................................................................................................78
List of Tables

Table 1. Theory Components ........................................................................................................39
Table 2. Virtues of a Good Theory as Illustrated by Wacker (1998), and The Virtues of ToIE...43
Table 3. Perceived Benefits and Outcome Expectations for The Three Stakeholders ............60
Table 4. The Needed Information of The Three Different Stakeholders .................................62
Table 5. The Number of Participants in Interviews and Focus Groups ...................................80
Table 6. The Demographic Data of The Participants .................................................................89
Table 7. Cronbach’s alpha, Composite Reliability, and Average Variance Extracted ............90
Table 8. Computed Mean of PU and US scores .........................................................................91
Table 9. PU Computed Mean Across the Roles .........................................................................91
Table 10. US Computed Mean Across the Roles .......................................................................91
Chapter 1. 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. These challenges include, but are not limited to, identifying different information needs (Dennis, 1996; Cress et al., 2006) for different stakeholders, analyzing different motivations towards information exchange (Nicolaou et al., 2013; Matschke et al., 2014; Zheng et al., 2013; Lin & Chang, 2018), and designing a communication channel for information flow (Rivard et al., 2019; Ko & Chang, 2018).

In the context of this dissertation, information exchange (IE) is defined as the acquisition and sharing of information among two or more stakeholders to improve decision quality. A stakeholder can be defined as an individual or an organization that has an interest in activities or outcomes of a project (Cleland 1985 as cited by McGrath & Whitty 2017; Pouloudi & Whitley 1997). Usually, stakeholders participate in information exchange activity when there is an information gap in which some information is needed to achieve a certain goal (Ye & Du, 2019).

The current IE literature mainly addresses issues related to the 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 (Lenert & McSwain, 2020; Lin & Chang, 2018; Rivard et al., 2019; Ko & Chang, 2018), either within the same organization or between relevant organizations, for the purpose of improving profit. However, there is no clear IE
framework, which would enable businesses or stakeholders to build their information exchange channels to improve decision-making. Without this framework, it would be difficult to design IE channels and decide on what information each stakeholder will need to make their decisions. Moreover, IE literature in IS mostly adopts the theories of social exchange, organization economy, organizational policy, or social cognitive theory to understand and explain IE from the business perspective. The usage of these theories focuses on specific business aspects, such as business performance, rather than focusing on information exchange itself. A plausible explanation for this adoption of different theories is the absence of the theory of information exchange that focuses on understanding information exchange itself, which has driven researchers to borrow and use different theories to study information exchange issues. That is not adequate because these theories were built to address specific issues; borrowing these theories and applying them to solve IE will not help much in addressing the phenomenon of IE.

Additionally, most of the 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, such as a supply chain. There is limited research about IE among multiple indirectly related stakeholders, some of whom may not have direct interactions. This dissertation seeks to address this limitation through a 3-step process. First, this dissertation seeks to propose a Theory of Information Exchange (ToIE) between multi-stakeholders, regardless their interactions, focusing on improving their decision-making process. Second, based on the proposed ToIE, this dissertation aims to design an Information Exchange and Decision Support (IEDS) framework for multiple stakeholders. The IEDS framework will be a blueprint to guide the design of IEDS applications that would facilitate information exchange among multiple stakeholders and improve their decision-making process. Finally, the IEDS framework is instantiated into an IE system. The IE
system is evaluated through an empirical study to demonstrate the usability of the IEDS framework.

Due to the absence of a theory of information exchange, the first step of this dissertation focuses on investigating and identifying factors that potentially motivate stakeholders to exchange their information to improve decision making. These factors can provide theoretic foundations for the IEDS framework design. For the second step, the IEDS framework focuses on designing an IE platform that facilitates the decision-making process among different stakeholders, instead of a narrow focus on improving business profit or performance. The framework will not only support multi-stakeholders’ information needs but also guide the information flow among them. The focus of the last step of this dissertation is to demonstrate the utility of the proposed IEDS framework. The proposed framework will guide the design of an IE platform artifact that connects non-profit organizations, governments, individuals, and companies. The IE platform artifact is evaluated using a case study to demonstrate if it is able to facilitate the information exchange among different stakeholders and improve their decision making.

The dissertation thus seeks to answer three research questions. The first research question is “what factors affect information exchange between multiple stakeholders to improve decision making?” The second research question is “what is the formal process (framework) that can guide the design of an IE platform for multiple stakeholders to improve decision making?” The last research question is “how can the framework be instantiated to provide IE for multi-stakeholders and improve their decision making?”
## 1.1 Research Gaps and the Proposed Solutions

Existing literature in IE has demonstrated IE’s effectiveness in improving the quality of business performance (Moberg et al., 2002; Hajli & Lin, 2016; Nicolaou et al., 2013), business communications (Naslund & Williamson, 2010), and facilitating the generation of new knowledge from shared information (Ko & Chang, 2018; Kallinikos, 2006). While many studies recommend IE across organizational boundaries, it is difficult to put it into practice (Naslund & Williamson, 2010). Even though existing literature provides a strong foundation for IE, most research has addressed IE for business purposes to connect relevant business parties; little research addresses the overall benefit of IE to create value for different stakeholders or even individuals. Below, is a set of research gaps in the IE literature that motivated this research.

1. Existing IE research focuses mainly on business values or performance, with limited attention to the stakeholders’ decision-making process.
2. Existing IE literature addresses the impact of IE on relevant business processes, such as the supply chain, but not the IE impact on different stakeholders including individuals.
3. Existing IE studies are based on different theories from other fields to explain the IE phenomenon, whereas a theory of IE is missing to explain how information exchange itself works.
4. There is no existing framework or formal process on how to design a platform that facilitates IE among multiple stakeholders for the purpose of improving decision making.

This means there is an opportunity to facilitate information exchange to multiple stakeholders (e.g., individuals and organizations) to give them the autonomy to make their own decision and to build a productive learning community that improves the overall decision-making process of every stakeholder. Common information, compared to the other types of information, gives users easy access to enrich and widen their knowledge and to incorporate this new information into their existing knowledge to expedite and rationalize their decision-making process.
1.2 Significance of the Research

Information exchange in the IS field has been widely studied in different areas such as knowledge sharing (Serenko & Bontis, 2016; Xiao et al., 2012; Camp & Sexton, 1992), healthcare (Ko & Chang, 2018; Rivard et al., 2019; Walker et al., 2016), supply chains (Moberg et al., 2002; Nicolaou et al., 2013; Naslund & Williamson, 2010; Homburg, 2000), and social media/virtual communities (Hajli & Lin, 2016; Hall et al., 2010; Zheng et al., 2013; Xiao et al., 2012; Lin & Chang, 2018).

However, because of the absence of a theory of information exchange, all the existing research adopts different theories from other fields to explain some specific aspects of information exchange. Some examples of the addressed aspects include an organization’s cost/benefit relationships of collaboration and cooperation using IE, the impact of IE on social media, and the factors that influence users to continue to exchange their information online. A theory of information exchange that explains and describes information exchange in the domain of IS would represent a significant contribution to the IE research in IS.

Furthermore, the exchange of information is important in professional practice for all organizations (Nicolaou et al., 2013) regardless of their business value. The world is increasingly connected with the overlapping needs among for-profit and non-profit businesses, and individuals. These multiple stakeholders would benefit from an IE platform that enables them to access and share information that could help them rationalize and speed up their decision making.

It is the case that IE literature has identified some important factors for IE, such as information quality, trust, control, and interactive tools, that would help to improve the communications between parties during the process of IE. A common framework that integrates
these factors for designing IE platforms would empirically validate the effectiveness of these factors.

This dissertation makes both theoretical and practical contributions. The theoretical contribution includes proposing a theory of information exchange using the theory of social exchange as a foundation and designing an IEDS framework. In practice, the IEDS framework can be applied in different business domains to guide the design of IE platforms. A case study also provides practical knowledge on how to apply the IEDS framework in the artifact design and demonstrates the effectiveness of the proposed theory and the IEDS framework.
Chapter 2. Literature Review

In order to understand the IE landscape, I first reviewed different types of systems that support IE as their primary purpose. These systems can be classified into three categories: group support system (Dennis, 1996; Dennis et al., 1998; Hilmer & Dennis, 2000), interactive visualizations techniques (Conati et al., 2014; Ko & Chang, 2018; Bajracharya et al., 2018; Rivard et al., 2019), and integrated systems (Homburg, 2000; Walker et al., 2016). Secondly, I reviewed different research streams of IE in IS and identified four main areas of research for IE. These streams are: employees’ knowledge sharing (Serenko & Bontis, 2016; Xiao et al., 2012; Camp & Sexton, 1992), health care (Ko & Chang, 2018; Rivard et al., 2019; Walker et al., 2016), supply chains (Moberg et al., 2002; Nicolaou et al., 2013; Naslund & Williamson, 2010; Homburg, 2000), and social media/virtual communities platforms (Hajli & Lin, 2016; Hall et al., 2010; Zheng et al., 2013; Xiao et al., 2012; Lin & Chang, 2018).

During the review process, I recognized there is not a theory of information exchange. Most of the current research has used theories from other fields. Hence, I performed a comprehensive literature review on existing theories, which I will explain in detail in Section 2.3. Additionally, because the purpose of this study is to design a platform for IE, I further reviewed the factors that could affect it.

In the following sections, I first review three types of IE systems in Section 2.1, and provide a critical analysis of main IE research areas in IS in Section 2.2. I then review existing theories that have been used for IE research in IS, and highlight the lack of a theory for IE in Section 2.3. Finally, different factors that motivate IE are reviewed in Section 2.4.
2.1 Existing Techniques for IE

Many studies have been done to develop techniques or systems of information exchange for the purpose of improving decision making and evaluating its effectiveness (Dennis, 1996; Homburg, 2000). Among popular tools that have been used for this purpose, Group Support Systems (GSS) (Dennis et al., 1998), interactive visualization systems (Bajracharya et al., 2018; Miller et al., 2012; Ko & Chang, 2018), and integrated systems (Homburg, 2000; Walker et al., 2016) are the most common. The benefits of these tools include parallelism where the system allows more than one member to provide information at the same time, group memory where group members have the ability to go back and check previously shared information, and anonymity where the reluctance to share is greatly reduced (Dennis, 1996). Other benefits include easy access to new information and the ability to extract new insights from the aggregated information (Ko & Chang, 2018; Rivard et al., 2019). These three main tools of IE are explained below.

2.1.1 Group Support Systems (GSS)

The effectiveness of group support systems (GSS) in expediting and improving the decision process has been extensively addressed in the literature (Dennis, 1996; Dennis et al., 1998; Hilmer & Dennis, 2000). A decision taken by group members is perceived, to some extent, to be more mature and realistic than one taken by individuals (Dennis, 1996). Decisions that are made by individuals or groups not using a GSS tend to be ill-structured and focus on some pieces of information. For this reason, business organizations often form groups from different backgrounds to make decisions rather than relying on individuals because the group will have access to a large pool of information that any individual could have (Dennis, 1996). When group
members have access to sufficient information they should be able to reach the optimal decision (Hilmer & Dennis, 2000).

Compared to non-GSS, GSS are perceived as being able to exchange more information, take less time, and enable better decisions (Dennis, Hilmer, & Taylor, 1998). For GSS to be effective, all group members should have access to the same information (common information) to be able to evaluate the options and come up with the best alternative. When the information is not shared between group members, the result is going to be poor decisions (Dennis et al., 1998). Thus, information sharing was found to positively influence the quality of the activities, the relationships between business partners, and the quality of the decision-making process (Hajli & Lin, 2016), (Nicolaou et al., 2013).

While GSS provide opportunities for IE, exchanging unique information is often done poorly and group members cannot easily share their unique information with other members (Dennis et al., 1998). Moreover, IE in GSS does not always allow group members to effectively use this information in their decision process nor does it guarantee the best alternative decision because this depends on participants' ability to analyze the newly received information and integrate it into their existing knowledge (Hilmer & Dennis, 2000; Dennis, 1996). Therefore, some means to effectively exchange unique information are needed (Dennis, 1996).

For the a GSS to be effective, it needs to maintain and facilitate the three activities that are involved in group decision making: *information recall, information exchange, and information processing* (Dennis et al., 1998). The quality of decision outcomes depends on to what extent the information is shared among group members (Dennis et al., 1998). Based on the information sharing status, information can be classified into three categories: *common information, unique information, and partially shared information*. First, *common information* is shared among and
accessed by all group members (Dennis et al., 1998). Second, unique information is known to one member but not to others (Dennis et al., 1998); and third, partially shared information is known to some members but not all (Dennis et al., 1998). In my proposed IEDS framework, while stakeholders will share their unique or partially-unique information, this shared information will be aggregated to represent common information in which every stakeholder will have access to it.

This classification of information is important because choosing the best alternative or evaluating decisions is usually more effective when group members have access to common information rather than the other two types. In his experiment, Dennis, (1996) found that groups who exchanged only a small portion of information made poor decisions compared to those who shared at least 50% of the information. The problem in GSS occurs when some group members do not share all the information with others either intentionally to favor some decisions (biases), or unintentionally by assuming that others already know the information (Dennis, 1996).

In online IE, people exchange a large amount of unique information, which is only known to the person who is doing the exchange, which eventually becomes common information and makes it available to others. However, due to time constraints or limits, people do not have the ability to analyze this exchanged information and incorporate it into their existing knowledge (Dennis et al., 1998; Hilmer & Dennis, 2000). Therefore, the resulting decision might not be as effective as it should be. My proposed solution is to develop an IE platform that removes the time constraint where people can easily access the information at any time, analyze it, and then use it for their own purpose.
2.1.2 Interactive Visualization Techniques

Information visualization is an important tool for information exchange. Visualization tools can be defined as the methods that are used to solve a visualization function, such as navigation, filtering, or selection (Conati et al., 2014). They can produce a static visual or interactive presentation of information clearly and compellingly (Miller et al., 2012). Visualization tools have been used in many fields such as healthcare, IS, supply chain, and education (Miller et al., 2012; Ko & Chang, 2018). They have become very popular for decision making, and they could be designed to fit the specific needs of each user (individual or organization) and support users with different backgrounds and abilities (Conati et al., 2014; Ko & Chang, 2018).

Information can be exchanged and visualized using different techniques such as groupware (Hilmer & Dennis, 2000), visualization tools (Miller et al., 2012; Ko & Chang, 2018; Rivard et al., 2019), and group value charts (Bajracharya et al., 2018; Conati et al., 2014). Visualization tools in IE are effective because they increase the possibility that important information will not be overlooked by individuals (Hilmer & Dennis, 2000), provide easy channels where firms can obtain useful insights from information and use them in their decision process (Ko & Chang, 2018; Lin & Chang, 2018; Rivard et al., 2019), and allow a comprehensive view of information that can provide decision support (Ko & Chang, 2018).

Among many systems that provide information visualization for IE, Bajracharya et al. (2018) developed an interactive visualization tool, called “value charts”, that makes group decision-analysis more participatory, transparent, and comprehensible. Value charts can be defined as a set of visualization tools that are used to help decision makers choose the best alternative (Conati et al., 2014). The idea behind the Group Value Charts tool is that it allows group members to input their individual decision or preference about a particular incident and then collectively
present the best alternative as well as the individual preferences, which provide a deeper understanding of the situation (Bajracharya et al., 2018). However, the performance of the value charts is affected by different user characteristics such as cognitive abilities and personality traits (Conati et al., 2014).

Bajracharya et al. (2018) found that Group Value Charts increased the quality and quantity of exchanged information because they enabled a systematic comparison between the alternatives during the decision process. This finding confirms what has been found previously by Miller et al. (2012) and Conati et al. (2014). Moreover, groupware applications were found as positively motivating exchange of information and improving decision outcomes (Hilmer & Dennis, 2000).

There are two types of visualization tools: static visualization that uses non-interactive tools where users can only view data without actual engagement (e.g., bar charts), and interactive visualization which allows users to perform specific tasks (e.g., filtering) (Conati et al., 2014; Michael & Sexton, 1992; Miller et al., 2012). The interactive tools give users the opportunity to process the exchanged information and meet their specific needs (Lin & Chang, 2018). Putting information in visualized categories encourages participants to analyze and integrate it into their decision process (Hilmer & Dennis, 2000). Interactive visualization tools are especially helpful because they provide easy and clear information representation that visually attracts the user’s attention, and it provides persuasion elements (Miller et al., 2012).

2.1.3 Integrated System

An attempt to provide IE between stakeholders was made through using an integrated system. Homburg (2000) defined an integrated system as “the standardization of data definitions and data structures through the use of a common conceptual scheme across a collection of data
sources” (p. 50). An example of an integrated system is a centralized database that contains all the relevant information of the participating organizations (Homburg, 2000).

Many studies have investigated the effectiveness of integrated systems and their impact on organizational performance not only within the organization but also beyond the boundaries of a particular organization (Homburg, 2000; Walker et al., 2016). Homburg (2000) investigated inter-organizational information systems that exceed organizational boundaries. He critiqued the assumption that the more integrated the system is the more successful the collaboration will be. He stated that, in practice, this integration usually results in “confusing power struggles, politicking, and sometimes manifest sabotage” because every organization will strive to increase its self-interest by reducing its dependence on others and increasing others’ dependence (Homburg, 2000, p. 49).

He argues that the problem of the integrated system is that it leads to some data structures and standards that benefit some participant organizations but not all organizations. Similarly, Naslund and Williamson (2010) state that information exchange can result in loss of information control and raise an information security issue. In contrast, Moberg et al. (2002) stated that business parties that have integrated systems reported a stronger performance, which positively affects customers’ perception of logistics, and improves business communications (Naslund & Williamson, 2010).

Homburg (2000) found that dependency avoidance, incentives, and shared ownership and control are the main factors that improve IE in integrated systems. In a study about the factors that influence inter-organizational information exchange, Nicolaou et al. (2013) found that information quality, risk perception, and trust are important factors that affect the organization’s decision to continue exchanging information. Information quality is a particularly important factor in IE
(Homburg, 2000; Zheng et al., 2013; Hilmer & Dennis, 2000) because it provides incentives for participants, increases trustworthiness, improves decision quality, and motivates the users’ overall intention to exchange their information (Homburg, 2000; Nicolaou et al., 2013).

2.2 IE Research Areas in IS

IE has been addressed in many research areas, and numerous studies have examined its effectiveness in improving business performance or decision making. Four main research areas for IE in IS are: knowledge sharing (Serenko & Bontis, 2016; Xiao et al., 2012; Camp & Sexton, 1992), healthcare (Ko & Chang, 2018; Rivard et al., 2019; Walker et al., 2016), supply chain (Moberg et al., 2002; Nicolaou et al., 2013; Naslund & Williamson, 2010; Homburg, 2000), and social media/virtual communities (Hajli & Lin, 2016; Hall et al., 2010; Zheng et al., 2013; Xiao et al., 2012; Lin & Chang, 2018).

In the healthcare domain, while some studies focused on using IE for improving internal business performance (Ko & Chang, 2018; Rivard et al., 2019; Walker et al., 2016), Lin and Chang (2018) investigated users’ health information exchange on social media platforms. They found that people usually seek help and get health information from others who they previously knew had a similar situation such as personal health awareness, treatment options, and personal success experiences such that they think might help them to deal with their own situations.

When it comes to the knowledge sharing domain, some studies identified the factors that motivate employees (Serenko & Bontis, 2016) or people in general (Xiao et al., 2012) to share their knowledge with others. While Serenko and Bontis (2016) develop an IE model and measure its impact on employees’ knowledge sharing within the organization, Xiao et al. (2012) focus on the factors that motivate people to share their knowledge on social media platforms. Camp and
Sexton (1992) examine technical knowledge sharing. They argue that what matters is creating business value from shared knowledge, not just the sharing itself. While this argument might be true, it is beyond the scope of this dissertation because the scope of this dissertation is the use of IE to facilitate the decision-making process of multi-stakeholders.

The supply chain is another domain that extensively uses IE to improve its business process. Moberg et al. (2002) examine the antecedents of IE in the supply chain to create business value and to improve the overall business performance between manufacturers and retailers. Nicolaou et al. (2013) addressed factors such as trust and risk perception that influence user perception of IE in the supply chain. Homburg (2000) and Naslund and Williamson (2010) focus on identifying factors, such as incentives (benefits), control, ownership, and dependency that influence IE performance.

While many studies have examined user’s IE on social media platforms, each study has looked at a different aspect. Hajli and Lin (2016) focused on privacy risk and perceived control on social media platforms. Hall et al. (2010) and Zheng et al. (2013) addressed rewards and existing relations as prerequisites for a successful online IE. Xiao et al. (2012) surveyed the effect of trust and outcome expectations on the continuous use of IE. Lin and Chang (2018) addressed the Facebook data of a health information exchange. They examined the effect of human-to-human and human-to-information interactions on users’ intention to exchange their information.

Although IE has been addressed in many research areas and numerous studies have examined its effectiveness in improving business performance or decision making, two main research streams are identified in the literature. The first attempts to identify characteristics of strong relationships between parties involved in IE, such as trust or risk perception. The second seeks to develop frameworks for maintaining these strong relationships (Moberg et al. 2002).
example, Naslund and Williamson (2010) created an IE framework for the supply chain that promotes collaboration and integration among participating businesses, and Serenko and Bontis (2016) proposed a knowledge sharing framework that helps managers to enhance IE among employees.

Despite the limitations of the IE research presented above, the current literature provides a strong foundation for Information Exchange. My proposed theory and framework combine these two research dimensions by adopting the characteristics of relationships between participating parties, such as generalized and productive modes; and incorporates the factors that were shown to significantly influence and maintain IE relationships.

The diverse use of IE in different fields shows the importance of this IE topic and the need for continuous efforts to improve its effectiveness. Most of the factors that were addressed in the above-mentioned studies will be considered in designing the IE framework, which is one of the purposes of this study. This also will help to provide a contribution to other fields where IE plays a significant role.

2.3 Existing Theories for IE in IS

To the best of my knowledge, among the numerous IE studies in IS, none have developed a theory of information exchange between multi-stakeholders. Instead, existing IE studies have applied different theories from other fields, such as social exchange theory, social cognitive theory, political organizational theory, and economic organizational theory. Among these theories, the theory of social exchange has been used most.

While some studies have attempted to combine two theories to address certain aspects of IE, such as the balance between the cost/benefit of IE or the conflict over ownership of information
(Lin & Chang, 2018; Homburg, 2000), most studies of IE in the IS field use the theory of social exchange as a theoretical foundation for their arguments (Serenko & Bontis, 2016; Zheng et al., 2013; Lin & Chang, 2018; Hall et al., 2010; Liao, McComas, & Connie Yuan, 2017; Xiao et al., 2012).

Among the theories used in IE literature, political and economic organizational theories do not help much in addressing the phenomenon of information exchange between multi-stakeholders to improve decision-making. Political organization theory is defined as “each organization strives to optimize its self-interest by (1) minimizing their dependence on other organizations and (2) maximizing the dependence of other organizations on themselves” (Homburg, 2000, p. 52). It basically strives to understand organizations’ self-interest and explains how to optimize their outcomes while dealing with other organizations. Economic organizational theory mainly focuses on standardizing data structures and definitions to reduce overall costs. It is used to address issues associated with reducing coordination costs and increasing the overall benefits between the participating organizations (Nicolaou et al., 2013; Homburg, 2000).

These two theories have been mainly used to address and resolve the resulting conflict that is associated with IE between participants. For example, Homburg (2000) used both theories to investigate the effectiveness of integrated systems in improving the collaboration between organizations in the context of addressing issues associated with system integration, such as conflicting power, data ownership, and politicking. These issues of economics and self-interest are out of the scope of my research because they are the consequences of information exchange, not the actual IE behavior that this study aims to investigate.

Social cognitive theory is also out of the scope of my research because it focuses more on personality traits or individual characteristics and examines people’s willingness to participate in
IE. For example, Conati et al. (2014) used social cognitive theory to address the impact of users’ characteristics on the use of value charts for data visualization. Similarly, Lin and Chang (2018) used the same theory to address the interaction effect of health information on social media platforms. Because the purpose of my research is to develop a Theory of Information Exchange (ToIE) for multi-stakeholders, regardless of their personality traits to improve decision making, I believe social cognitive theory will not help at this point.

Among those identified theories, the theory of social exchange is the only theory that I found relevant to my research and I decided to consider it as a theoretical foundation in this research.

### 2.3.1 Theory of Social Exchange

The theory of social exchange (TSE) is well-established and has been used to address IE in several IS studies (Serenko & Bontis, 2016; Lin & Chang, 2018; Hall et al., 2010). It has been used to explain individual social behaviors from the benefit and cost perspectives. Serenko and Bontis (2016) define it as “a joint activity of two or more players when each actor possesses and may offer something valuable from the other actors’ perspective” (p. 690). Lin and Chang (2018, p. 771) define it as “people sharing their information may perceive it to be fair when others do the same thing, and such fairness perception will lead to greater social interactions”. Thus, TSE suggests that people engage in certain social behavior to maximize benefits and reduce costs (Lin & Chang, 2018) and to get some kind of rewards (Zheng et al., 2013). TSE can also be used to explain online information exchange behavior (Hall et al., 2010). The theory of social exchange can be stated in terms of the maxim: When you do a favor to others, people would do the same to you.
Most IS studies that use TSE have focused on the economic side of social exchange such as reducing costs or increasing benefits. TSE explains the behavior of individuals’ who produce benefits for the receiver which may prompt some form of reciprocal benefits or rewarding expectations (Serenko & Bontis, 2016). Depending on the rewarding expectations, social exchanges can be classified into four distinct modes: negotiated, reciprocated, generalized, and productive (Liao et al., 2017; Serenko & Bontis, 2016).

In the “negotiated mode” individuals clearly establish rewarding or reciprocal conditions before the exchange takes place; in the “reciprocated mode”, no reciprocal conditions are established, but a sender believes that the recipient will eventually share something in return. The “generalized mode” means that individuals assume when they share their knowledge, others will share theirs later. In the “productive mode”, all individuals collaboratively share their knowledge to produce a common good and to help others unconditionally (Serenko Bontis, 2016). This classification is relevant to my research because my proposed IE framework will focus more on generalized and productive modes, which have been found to have a more positive impact on knowledge sharing (Serenko & Bontis, 2016; Liao et al., 2017).

The theory of social exchange could include the exchange of anything such as goods or services, one of which could be information (Serenko & Bontis, 2016; Liao et al., 2017). Thus, one may consider information exchange as a type of social exchange, which might explain the extensive use of this theory in addressing information exchange. However, three unique characteristics of information exchange differentiate it from other forms of social exchanges.

First, the information exchange process includes three unique steps: information recall, information exchange, and information processing (Dennis et al., 1998). This process is different from other forms of social exchange where none of these steps are required during the exchange.
of goods or services. Second, the unique usage of exchanged information would have a different impact on the person or the organization who received information depending on how the information is being evaluated and used (Dennis, 1996). Third, unlike goods or services that are exchanged for one-time consumption, the information exchanged can be re-shared and has a long-lasting impact. These characteristics are not addressed well in the theory of social exchange, which focuses mainly on individuals’ exchange behaviors based on cost and reward factors. These information characteristics promote the need to develop a theory of information exchange.

2.4 Factors that Motivate IE

The reason that I am addressing the motivation factors is that many studies identified one of the key success factors in IE is how to motivate people to exchange their information. Not all people are motivated to share their information with others. Some studies address the factors that motivate people to share or not to share their information (Serenko & Bontis, 2016; Zheng et al., 2013; Lin & Chang, 2018). Matschke et al. (2014, p. 549) found that “internal motivation, the gain of prestige, and quality and quantity of content are the strongest motivational factors enhancing participation, whereas time and effort for contribution and fear of personal feedback are the strongest factors hindering contribution.” Some other factors that motivate IE include existing relationships between participants (Hall et al., 2010) as well as personal characteristics such as cognitive and personality traits (Conati et al., 2014).

Many factors that influence online IE have been identified. Among these factors, information quality was found to be significant because it affects the continuous use of IE (Moberg et al., 2002; Hilmer & Dennis, 2000; Zheng et al., 2013; Nicolaou et al., 2013). Information quality can be defined in terms of information format, accuracy, and timeline (Moberg et al., 2002). In
their study that surveyed 221 business professionals in the supply chain industry, Nicolaou et al. (2013) conclude that information quality directly affects trust and risk perception, which ultimately affects users’ desire to exchange their information. Similarly, Moberg et al. (2002) found information quality to be an important factor for IE. Furthermore, Hilmer and Dennis (2000) stated that information quality allows participants to analyze the exchanged information and incorporate it into their knowledge during the decision-making process.

System quality is another factor that influences IE that is mentioned frequently in the literature (Zheng et al., 2013; Hilmer & Dennis, 2000). System quality means the ease of use and the time and effort required to use the platform, and engage with the content (Hilmer & Dennis, 2000). Based on a field survey of 284 participants, Zheng et al. (2013) found that information and system quality directly affect individual benefits and user satisfaction, which ultimately determine users’ intention to exchange their information.

Interactive visualization of information could be one aspect of system quality that reduces the required effort to find particular information (Hilmer & Dennis, 2000; Bajracharya et al., 2018; Miller et al., 2012). Interactive visualization of information could be one aspect of system quality that allows users to make their decision more easily by enabling them to find needed information more easily (Hilmer & Dennis, 2000; Bajracharya et al., 2018; Miller et al., 2012).

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). Perceived benefits can be categorized as monetary or non-monetary benefits. Examples of non-monetary perceived benefits include information and social benefits, such as access to more information or recognition
(Zheng et al., 2013); while examples of monetary perceived benefits include increased ROI, increased sales, decreased inventory, improved flexibility, and better-utilized resources (Naslund & Williamson, 2010). Moreover, perceived benefits have two levels: individual and organizational. An individual-level perceived benefit occurs when a person performs a specific behavior to get some benefits for him- or herself, such as recognition. Organization-level perceived benefits occur when the employees collectively perform behaviors to benefit the overall organization, such as increasing ROI, which will benefit the overall organization.

Outcome expectation is the anticipated value or the expected consequences of individual behaviors (Lin & Chang, 2018; Xiao et al., 2012). Individuals can exchange knowledge in virtual communities with the expectations of enriching their personal knowledge, seeking social support, making friends, and so on (Xiao et al., 2012).

Lin and Chang (2018) found that outcome expectation is a significant factor that mediates the influence of human and information interaction on the use of IE. Homburg (2000) and Hilmer and Dennis (2000) found that incentives are of vital importance because they increase the quality of exchanged information. Xiao et al. (2012) developed a theoretical model that predicts an individual’s online information exchange behavior. They used trust and outcome expectations as factors that mediate the relationship between the online social community and the effect of knowledge exchange. They conclude that perceived trust and outcome expectations are important elements influencing information exchange in the online community. Furthermore, information benefits, such as access to new information, as well as social benefits that people will get by being voluntary participants in the information exchange would encourage and motivate them to continue participating in such activity (Zheng et al., 2013).
The factors that motivate people to share or not to share their information can be classified under four main categories; environmental, personal, cultural, and interpersonal as shown in Table 1 (Matschke et al., 2014). However, the scope of this research will focus on information quality, system quality, perceived benefits, and outcome expectations as motivations for IE among multiple stakeholders in the proposed theory and framework. This is because these factors can be measured and have a significant influence on IE as stated above. Other factors such as personality and cultural factors will be left for future research.

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Personal factors</th>
<th>Interpersonal factors</th>
<th>Socio-cultural factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability</td>
<td>Lack of understanding</td>
<td>Direct contact</td>
<td>Group identification</td>
</tr>
<tr>
<td>Stability and security</td>
<td>Description difficulties</td>
<td>Interpersonal trust</td>
<td>Knowledge perceived as private/organizational good</td>
</tr>
<tr>
<td>Privacy and clarity in legal rights</td>
<td>Internal motivation</td>
<td>Fear of exploitation</td>
<td>Knowledge awareness</td>
</tr>
<tr>
<td>Time requirements</td>
<td>Self-efficacy expectation</td>
<td>Reciprocity expectation</td>
<td>Guidelines for contributions</td>
</tr>
<tr>
<td>Effort requirements</td>
<td>Tool competence</td>
<td>Fear of loss of knowledge advantage</td>
<td>Organizational culture to exchange information</td>
</tr>
<tr>
<td>Quality of content</td>
<td></td>
<td>Privilege in information</td>
<td>Expectation of others’ cooperativeness</td>
</tr>
<tr>
<td>Quality of content</td>
<td></td>
<td>Fear of losing face</td>
<td>Collective efficacy expectation</td>
</tr>
<tr>
<td>Activity</td>
<td></td>
<td>Gain of prestige</td>
<td>Instrumentality for organizational goals</td>
</tr>
<tr>
<td>Traffic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure of platform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External reinforcement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anonymity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identifiability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future prospects</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. Categories of IE Motivational Factors (Matschke et al., 2014)*
Chapter 3. Research Methodology

As stated above, this research targets three objectives: 1) proposing a theory of information exchange (ToIE), 2) designing an IEDS framework for different stakeholders, and 3) building an online IE platform based on the proposed framework and theory.

For the first objective, proposing a theory, this research seeks to develop a theory of information exchange that would help to explain and understand the phenomenon of information exchange among multiple stakeholders with a focus on facilitating and rationalizing decision-making to achieve better decisions in terms of process and quality. Usually, when we have access to relevant and comprehensive information, the resulting decision will have better quality (Dennis, 1996). The focus here is on addressing the effect of information exchange among multi-stakeholders on improving decision quality. In this case, better decision quality is not efficacy. This is not to indicate that decision efficacy is not important, rather I believe that, in most cases, 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). For example, the quality of the decision that considers comprehensive and relevant information can be characterized as rational, at least at the time where the decision is being made and is not random or arbitrary.

Proposing this theory is done by addressing the factors and relationships of IE which have been identified in the literature and then develop propositions that specifically address the exchange of information. The propositions developed in this research can provide guidance for researchers who are interested in testing the proposed theory. It can also be used to guide the IE platform design that will be discussed in Chapter 6. Testing the IE theory is out of scope of this dissertation. Two methods are used in this research based on the objective of the research as explained below.
3.1 Proposing a Theory

There are many methods for proposing a theory. One popular method of theory development is using the grounded theory methodology (GTM). GTM uses an inductive approach in which the researcher uses external data to test if a specific relationship holds true in the real-world (Myers, 2013, p. 104). GTM is a popular methodology for theory building because it provides a very structured approach. Another method of theory development is the analytical deductive approach in which the researcher develops new insights by logically building relationships between carefully predefined factors and develops propositions (Wacker, 1998). Kivunja (2018) stated that a good deductive theory is one that has its roots in the literature, provides intellectual understanding, and predicts something that has not been yet investigated in the research. Walker et al. (2016) used propositions to develop a conceptual model that addresses the relationships between health information exchange systems (HIEs) and participating provider organizations. Similarly, Waldman (1994) used propositions to propose a theory of work performance.

While these two methods of proposing theories are popular, this dissertation uses the analytical deductive approach to develop the theory of information exchange. This is due to the fact that the factors and the relationships that I am using to build the theory are already identified in different theories, such as the theory of social exchange. The proposed theory, ToIE, addresses the previously identified factors with a focus on information exchange, which is different from any other type of exchange such as goods or services, between multi-stakeholders.

This dissertation did not use grounded theory for two reasons. First, grounded theory is usually used when the researcher is trying to generate theory from data. The researcher collects data, analyzes it, finds the patterns, and then comes up with a theory. Second, to use a grounded
theory method, the researcher should not be guided by any previous theory which might limit the invention of the new theory (Myers, 2013, p. 104). In my research, I am trying to propose theory not from data but from the relevant factors that were previously identified in the literature. Moreover, my research uses the theory of social exchange as a theoretical foundation and builds on it.

To apply the analytical deductive approach, I followed the steps explained by Wacker (1998). First, I performed a comprehensive literature review on different research streams and related theories of IE in IS. The review revealed the lack of information exchange theory in IS research. Second, I reviewed factors that would motivate IE behavior and influence IE outcomes. Lastly, based on the findings from the previous steps, I developed propositions to explain the factors that would influence information exchange among multiple stakeholders and how the factors would impact the stakeholder’s decision-making process. The proposed Theory of Information Exchange, ToIE, addresses these previously identified factors with the focus of information exchange through an information system among multi-stakeholders.

3.2 Building an IEDS Framework and IE Platform

For the second and third objectives, which are designing an IEDS framework for different stakeholders and building an online IE platform, the design science research (DSR) method is adopted to guide artifact development and evaluation. This is because the goal of this research is to solve a human problem by developing artifacts. The accepted way to do so is by using DSR (Hevner et al., 2004).

Over the last decade, DSR has become an important research method in the information systems field (Hevner & Chatterjee 2010). It is a research method that is concerned with building
artifacts to solve human problems. DSR strives to answer questions that are relevant to humans by creating artifacts. The outcome of DSR could be either of two things: descriptive research, which deals with knowledge discovery, such as theory building, and justification; or prescriptive research, which deals with knowledge of using, such as producing man-made objects. The prescriptive outcomes of DSR could be a construct, model, method, or instantiation (Hevner et al., 2004). DSR usually takes the problem-solving path and provides solutions for identified problems or improves existing solutions.

Chatterjee and Hevner (2010, p. 2) defined DSR as an “iterative process and resulting product that deals with building artifact to solve a human problem in an efficient manner”. Iteration is an integral part of DSR because it starts with identifying the problem, designs and builds a solution, evaluates the outcome, and then seeks possible improvements. Therefore, the main process cycles of DSR are building and evaluating the artifacts. To do so, two other cycles are important, which are the rigor and relevance cycles. The rigor cycle means that the method of developing and applying the attempted solutions is based on the foundation and the knowledge base of the previous research in the field. The relevance cycle means that the resulting solution is applied to a business, organizational, or societal need in a relevant environment in which it adds back to the knowledge base (Hevner et al., 2004).

Among many attempts that try to provide a mental model or a roadmap for conducting a DSR, Peffers et al. (2007) develop a DSR model that guides researchers and helps them to predict expected outcomes. This model specifies the research starting point, which could be one of the following: 1) problem-centered initiation, where the researcher is trying to solve an unsolved problem, 2) objective-centered initiation, where the researcher is trying to provide a better solution to a solved problem, 3) design-centered initiation, which focuses on the artifact itself, and 4) client
context initiated, which is relevant to a particular client. This research will be an objective-centered initiation that aims to provide a better solution to the problem of IE between multi-stakeholders. The artifacts of this research are a framework and a platform for IE. This research will follow the guidelines of DSR (Hevner et al., 2004) and the DSR model of Peffers et al. (2008).

The first artifact, an IEDS framework, is based on the factors which are addressed by the ToIE and provide the necessary steps and elements for information exchange among different stakeholders. The IEDS framework is evaluated by instantiating and building an IE platform (i.e., the second artifact) that connects scholarship organizations or sponsors, employers, and students, and facilitates information exchange among the different stakeholders from these entities to potentially improve their decision making. Focus group discussions with different stakeholders was conducted to identify needed features of the IE platform. After building the IE platform with the needed features, stakeholders were trained to use the platform. The IE platform is evaluated using qualitative and quantitative methods to demonstrate its utility in three areas: ease of use, usability, and effectiveness of the platform in facilitating the decision-making process. The qualitative method includes semi-structured interviews with different stakeholders of the IE platform. The quantitative method includes an online survey.

Due to the limited number of scholarship organizations and employers where this study is applied, five scholarship organizations and four employers participated in this study. For students, because this is an exploratory study, 27 students participated for the purpose of evaluation. Chapter 6 explains in detail all the data collection and evaluation techniques.
Chapter 4. A Theory of Information Exchange (ToIE)

To develop a ToIE, I adopted the analytical deductive approach and followed the steps explained by Wacker (1998). First, I performed a comprehensive literature review on different research streams and related theories of IE in IS. The review revealed the lack of information exchange theory in IS research. Current IE literature in IS mostly adopts theories from other fields, such as social exchange theory, theories from organizational economics and organizational policy, or social cognitive theory to understand and explain IE from the business perspective, such as the impact of IE on business performance and the costs and benefits of IE within an organization. There is an absence of an IS theory to understand information exchange with respect to the stakeholders’ decision-making process.

Second, I reviewed factors that would motivate IE behavior and influence IE outcomes. Four main factors were identified including information quality (Moberg et al., 2002; Hilmer & Dennis, 2000; Zheng et al., 2013; Nicolaou et al., 2013), system quality (Zheng et al., 2013; Hilmer & Dennis, 2000), perceived benefits (Lin & Chang, 2018; Homburg, 2000; Hall et al., 2010; Xiao et al., 2012; Zheng et al., 2013; Cress, Kimmerle, & Hesse, 2006), and outcome expectation (Lin & Chang, 2018; Xiao et al., 2012).

Lastly, based on the findings from the previous steps, I developed propositions by logically building relationships between the identified factors, as explained by Wacker (1998). I developed propositions to explain how these factors would influence information exchange among multiple stakeholders and how they would influence the decision-making process.

The proposed theory of information exchange (ToIE) for multiple stakeholders can be 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”. The idea is that the more access to comprehensive and relevant information from a variety of sources stakeholders have, the more the decision-making quality will improve.

The theory works as shown in Figure 2. The identified motivational factors: information quality, system quality, perceived benefits, and outcome expectations, will encourage stakeholders to exchange their unique information. When stakeholders share their unique information and feed it into the system, the aggregated information from different stakeholders will represent “common information” where every stakeholder will have a comprehensive view of the information that is relevant to the situation in which the decision needs to be made. The access to comprehensive common information will lead to a better decision quality that is characterized as not arbitrary or random but rationalized and timely.

Figure 2. Proposed theory of Information Exchange (ToIE)
4.1 Propositions of ToIE

4.1.1 Common Information

The quality of decision outcomes depends on to what extent the information is shared among group members (Dennis et al., 1998). Based on the information shared status, information can be classified into three categories: common information, unique information, and partially shared information. First, common information is shared and accessed among all group members (Dennis et al., 1998). Second, unique information is known to one member but not to others (Dennis et al., 1998); and third, partially shared information is known to some members but not all (Dennis et al., 1998).

This classification of information is important because choosing the best alternative or evaluating the decisions are usually more effective when group members have access to common information than the other two types. In his experiment, Dennis (1996) found that groups who exchanged only a small portion of information made poor decisions compared to those who shared at least 50% of the information. When the information is not shared between the group members, the result is going to be poor decisions (Dennis et al., 1998). As a result, information sharing was found to positively influence the quality of the activities and the relationships between business partners, and quality of the decision-making process (Hajli & Lin, 2016; Nicolaou et al., 2013). When stakeholders exchange their unique information, the aggregated unique information will create common information that stakeholders can use to improve their decisions. Therefore, the impact of exchanging unique information on improving decision making is mediated by common information. This leads to Proposition1:
When stakeholders have access to common information and integrate it into their unique information during the process of decision-making, the quality of the decision will be much better than when only unique information is considered.

4.1.2 Unique Information Exchange

As some stakeholders share their unique information and become active in IE, other stakeholders who benefit from this information will do the same and share theirs as well. Therefore, each stakeholder needs to share their unique, but not sensitive, information and make them common to others so they can use them for their needs. Building on social exchange theory, “people sharing their information may perceive it to be fair when others do the same thing” (Lin & Chang, 2018), stakeholders who benefit from the shared information will feel the responsibility to share their unique information with others. This will allow building a valuable information platform that would help stakeholders to rationalize their decisions, which leads to Proposition 2:

*As some stakeholders share their unique information, there will be an increasing tendency of other stakeholders who perceive the benefits to share their unique information as well; as a result, the overall unique information exchange will increase.*

4.1.3 System Quality and Information Quality

The quality of the exchanged information, which includes the format, accuracy, and sequence (Moberg et al., 2002) was found as a significant factor that affects the continuous use of IE and motivates users to exchange their information (Moberg et al., 2002; Hilmer & Dennis, 2000; Zheng et al., 2013; Nicolaou et al., 2013). Furthermore, Hilmer and Dennis (2000) stated that information quality allows participants to analyze the exchanged information and incorporate it into their knowledge during the decision-making process.
Another factor that motivates IE is system quality. System quality can be depicted in terms of the ease of use, or the time and effort required to use the platform (Hilmer & Dennis, 2000). Both system and information quality were found to directly affect the individual benefits and user satisfaction (Delone and McLean, 2013), which ultimately determine users’ intention to exchange their information (Zheng et al., 2013). According to the channel disposition model (Swanson, 1982, as cited by Davis, 1989), information quality and system quality are the main components that users use to tradeoff between using a particular system or not. When stakeholders find the shared information accurate and up to date and the system is easy to use and no extra effort is required, they will not only use this exchanged information (Davis, 1989) and incorporate it into their decision but also they will be motivated to share similar quality information.

Therefore, the impact of information quality and system quality on decision making is mediated by the exchange of unique information and the access to common information. Moreover, the impact of information quality and system quality on common information is mediated by the exchange of unique information. This explains Proposition 3:

*Information quality and system quality will yield greater value of information access to participating stakeholders which will motivate other stakeholders to exchange their information.*

The common information will be presented in the system in an interactive way where stakeholders can easily engage with the information, filter it, and categorize it according to their own needs. Three main factors were identified to help stakeholders engage in information exchange behavior; ease of use, effort required (Hilmer & Dennis 2000), and visualization (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012) to facilitate navigation, filtering, or selection (Conati et al., 2014).
Ease of use (i.e., the required effort to use the system) factor is already accepted construct in the literature as explained by TAM theory (Davis, 1989). If the system is perceived as difficult to use, participants may not exert sufficient effort to process it (Hilmer & Dennis 2000). The designed system is expected to efficiently and effectively allow users to participate in using it for the purpose for which it was designed (Zheng et al., 2013). When the system is easy to use, enjoyable, and requires no extra effort, users are more likely to adopt it (Hilmer & Dennis, 2000; Zheng et al., 2013).

Visualization tools in IE have been shown to be effective because they increase the possibility that important information will not be overlooked by individuals (Hilmer & Dennis, 2000). They provide easy channels where firms can obtain useful insights from information and use them in their decision process (Ko & Chang, 2018; Lin & Chang, 2018; Rivard et al., 2019), and they allow users to have a comprehensive view of information that can provide decision support (Ko & Chang, 2018). This will allow stakeholders to engage with the system and effectively participate in exchanging their information, which will lead to improving the overall decision process. This leads to Proposition 4:

*Ease of use, effort required, and interactive visualization will lead to more engagement in information exchange.*

### 4.1.4 Perceived Benefits and Outcome Expectations

The other two determinants of the IE are perceived benefits and outcome expectations (Lin & Chang 2018; Homburg 2000; Hall et al. 2010; Xiao et al. 2012; Zheng et al. 2013; Cress et al. 2006). While perceived benefits can be depicted as the access to more information or recognition
(Zheng et al., 2013), outcome expectations may include improving personal knowledge, seeking social support, and making friends (Xiao et al., 2012).

Perceived benefits and outcome expectations are important factors that influence information exchange in an online community (Xiao et al. 2012). Furthermore, information benefits, such as access to new information, as well as social benefits that people will receive by being voluntary participants in the information exchange would encourage and motivate them to continue participating in information exchange (Zheng et al. 2013).

Xiao et al. (2012) found that outcome expectation significantly influences knowledge exchange. Moreover, Lin and Chang (2018) found that outcome expectation has a significant impact on health information exchange on social media platforms. Additionally, Zheng et al. (2013) found that perceived benefits are positively related to users' continuance intention to use a system to participate in an online community. When users receive benefits by participating in an online community, they will be more encouraged to continue their involvement and participation (Zheng et al. 2013).

According to the theory of social exchange (TSE), the behavior of individuals who produce benefits for the receiver may prompt some form of reciprocal benefits or rewarding expectations (Serenko & Bontis, 2016). Depending on the rewarding expectations (explained above under TSE), people will engage in such social behavior (ToIE Proposition 2). When people participate in such social behavior as exchanging their unique information, the aggregated unique information will create common information, which stakeholders can use to improve their decision making (ToIE Proposition 1).

Therefore, the impact of perceived benefits and outcome expectations on decision making is mediated by the exchange of unique information and the access to common information.
Moreover, the impact of perceived benefits and outcome expectations on common information is mediated by the exchange of unique information. This leads to Proposition 5:

Perceived benefits and outcome expectations will motivate stakeholders to exchange their information.

As these identified factors motivate different stakeholders to participate in information exchange, a large amount of high-quality information will be shared across stakeholders. As a result, each stakeholder will have access to a large pool of information that can be used during the decision-making process. This is similar to group decision support systems that facilitate multiple people in an organization to make group decisions by providing them with access to a large pool of information rather than just information that an individual would have (Dennis 1996). Compared to using information that is not share, groups who have access to more information would be able to reach a decision that is closer to optimal (Hilmer & Dennis 2000). The proposed IE theory would motivate different stakeholders, not limited to organizational boundaries, to share quality information, and improve their decision quality. Thus, Proposition 6 is as follows:

Stakeholders will have a greater potential to improve their decision-making process when they have access to a large amount of accurate information that is shared among themselves.

4.2 Evaluation of ToIE

The proposed ToIE aims to provide a clear explanation of information exchange behavior among multiple stakeholders to improve the decision-making process. The ToIE bridges the gap of the absence of IE theory in IS research by reducing the need for borrowing different theories to explain IE activities. The method used to propose the theory is an analytical deductive approach
that allows identifying the underlying relationship between pre-identified variables (Wacker, 1998). To provide a brief qualitative evaluation for the ToIE, I first illustrate that ToIE fits the academic definition of theory with all the necessary components. Then, I demonstrate that the ToIE has virtues of a good theory.

4.2.1. ToIE as a theory

In general, a theory is defined as “a generalized statement of abstractions or ideas that asserts, explains or predicts relationships or connections between or among phenomena, within the limits of critical bounding assumptions that the theory explicitly makes” (Gabriel, 2008 as cited by Kivunja, 2018, p. 45). Three main characteristics of a theory are highlighted in this definition: the abstraction of the idea, the explanation or prediction of the relationships among the variables, and the bounding assumptions of the theory.

For the first characteristic, ToIE provides a generalized statement of abstraction 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”. For the second characteristic, ToIE explains and predicts the relationships between the identified variables and the access to “common information” to predict the effectiveness of the decision-making process for multiple stakeholders. For the third characteristic, ToIE has a specific bounding assumption: the more access to comprehensive and relevant information a group has, the more the decision-making process will improve, regardless of the domain in which IE is applied. The theory also limits the boundaries of its applicability to information exchange, not the exchange of goods or services, among different stakeholders to predict the quality of the decision-making process. Based on above discussion, ToIE fits well the academic definition of a theory as it meets all the aspects highlighted by the theory definition.
In addition to fitting the theory definition, ToIE also shows how it is developed, what it represents, and where it could be applied with its possible outcomes. Kivunja (2018) stated that a good deductive theory has roots in the literature, it provides intellectual understanding, and predicts something that has not been yet investigated by researchers. By reflecting this on the proposed ToIE, it can be seen that ToIE has its deep roots in the literature where all of its variables are defined; the ToIE theory provides a simple mental model by visualizing the variables and relationships among them; and finally, the idea of proposing IE theory in IS research is not addressed yet where all the current IE research borrows different theories, as explained in the above literature review. Therefore, the ToIE will help researchers to investigate the factors that are critical for understanding the real-life situations of IE among different stakeholders and help to explain IE behavior to solve IE problems.

Second, ToIE has all the four main components of a theory (see Table 1). They are: 1. Definitions of terms or variables, 2. a domain where the theory applies, 3. a set of relationships of variables, and 4. specific predictions (Hunt 1991; Bunge, 1967; Reynolds, 1971 as cited by Wacker, 1998). For the first component, the ToIE has a clear unique definition for each variable. These variables are well defined in the literature, which eliminates the use of further not relevant assumptions where these variables and the theory is applied. The literature has a clear unique definition for each variable used in the theory, as explained above in the literature review, and these definitions have been used in the literature, which proves that these definitions are agreed upon by academics.
**Table 1. Theory Components**

<table>
<thead>
<tr>
<th>Theory Component</th>
<th>ToIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definitions of terms or variables.</td>
<td>The ToIE has a clear unique definition for each variable</td>
</tr>
<tr>
<td>2. Domain where the theory applies</td>
<td>The ToIE domain uses IS to exchange information among multiple stakeholders for improving decision making. It specifies the boundaries where ToIE applies.</td>
</tr>
<tr>
<td>3. Set of relationships of variables</td>
<td>The relationships between the identified variables were carefully determined using the logic of the analytical deductive method.</td>
</tr>
<tr>
<td>4. Specific predictions</td>
<td>The prediction of the ToIE is precisely specified in terms of improving decision-making.</td>
</tr>
</tbody>
</table>

While the antecedent motivational factors are similar to those in the existing literature, such as DeLone and McLean’s (2004) information success model, ToIE includes two DSS constructs, unique information and common information, that are unique in the context of information exchange among multi-stakeholders. These two new constructs are important because the ToIE seeks to improve the decision making of every participating stakeholder who may have different information needs. Additionally, ToIE provides new insights into relationships between antecedent motivation factors and different types of information, and how these would affect decisions. For instance, system quality (Zheng et al., 2013; Hilmer & Dennis, 2000) and information quality (Moberg et al., 2002; Nicolaou et al., 2013; Hilmer & Dennis, 2000) are agreed upon by academics; however, ToIE shows that interactive visualization tools can increase ease of use and motivate
required effort. Interactive visualization also helps in reducing the required effort to reach particular information and allows users to reach the needed information more easily.

Similarly, although perceived benefits is a key construct in the literature (Zheng et al., 2013), ToIE uniquely categorizes the benefits as monetary or non-monetary. Non-monetary benefits include access to more information and/or recognition (Zheng et al., 2013). Monetary benefits include increases in return on investment, increases in sales, decreases in inventory, improved flexibility, and better-utilizing resources (Naslund & Williamson, 2010). For outcome expectations, ToIE considers relevant factors such as enriching knowledge and seeking social support as influencers for IE behavior (Lin and Chang 2018; Xiao et al. 2012). These unique considerations of perceived benefits and outcome expectations address the needs of multiple stakeholders that are not limited to these from for-profit organizations (e.g., NGOs).

For the second component, the domain of ToIE is clearly set and identified. The domain of this theory is Information Systems that exchange information among multiple stakeholders to support decision making. Identifying the domain is critically important for theory testing which provides specifications in which the theory to be applied which reduces the possible refutation of inapplicable situations. The domain of ToIE is wide enough in which it could be applied in any domain as long as its boundaries exist.

ToIE theory has clearly defined boundaries to provide specifications about where, when, and how the theory may be applied. The boundaries of the ToIE are as follows: First, ToIE is only applicable in the context of information exchange and is different from the exchange of goods or services. Second, ToIE assumes that IE behavior involves two or more stakeholders who have common interests in activities in which they are engaging. That is, each stakeholder would have some perceived benefits or expected outcomes to maximize their benefits and get some reward.
from the IE process. Third, ToIE assumes that information exchange is through an information system that facilitates the IE activities. The selected system for IE has to maintain information quality and system quality factors that are explained above and highlighted by the ToIE. Lastly, ToIE assumes that the objective of stakeholders participating in the IE activities is to improve their own decision quality, instead of achieving a consensus.

For the third component, the relationships between the identified variables were carefully determined using the logic of the analytical deductive method. The propositions of the theory develop new insights by logically building relationships between predefined factors in the literature. The theory is simple enough to show the relationships between the related factors, and the propositions show how these factors are related to each other.

To ensure the internal consistency of the theory, the relationships between the factors were specified before data is collected. Additionally, the identified variables complement one another in a way that covers many aspects of the information exchange context. For instance, ToIE theory not only covers the quality of the information and the quality of the system, but it also covers the social support aspect, which is very critical for the success of information exchange.

For the fourth component, the prediction of the ToIE is precisely specified in terms of improving the decision-making process, which provides a tool to test empirically the theory in real-world situations. To test this theory, a person needs to maintain all the conditions and the boundaries mentioned above and monitor the predicted outcome.

4.2.2 ToIE virtues of a good theory
In this section, I demonstrate that the ToIE has virtues of a good theory based on Wacker (1998). Table 2 lists these virtues and their definitions, and summarizes how ToIE achieves these good virtues. The virtue of empirical riskiness is not included in the table because the ToIE is a proposed theory and it has not been tested yet; therefore, the applicability of the empirical riskiness virtue might be hard to tell at this point. However, it is possible that the theory could be refuted at any occurrence where the observation of IE behavior does not meet the expected outcomes.

By applying these virtues to the proposed theory, we can recognize that the ToIE is unique and does not replace other theories because no theory has been developed yet that explains information exchange between multi-stakeholders to improve the decision quality of each stakeholder. Although different theories have been used to address IE, ToIE is new because it has been developed specifically for the IE domain to improve decision making. Existing theories either focus on a general exchange such as goods or services with the assumption that information could fit within one of these categories, or they address IE from the point of view of reaching consensus between participants as in the case of GSS. ToIE is not meant to replace these theories, however, if ToIE demonstrates better results, it could.

ToIE is generalizable because it could be applied in different areas given that an information system is being used as a medium for information exchange behavior between different stakeholders to improve the decision-making process. In addition, ToIE has a simple definition and limited assumptions, as stated above, which maintains the parsimony virtue of theory. Moreover, because the ToIE is a new proposed theory, it provides new areas for investigations such as the ability to develop and test its propositions, hypotheses and design new models. Furthermore, ToIE will open new areas of research to address the impact of information
types to improve the decision making of each participating stakeholder. This could be further extended to investigate its applicability in different IE contexts.

Finally, ToIE is an abstract statement which means that the theory integrates many relationships and variables, which gives the theory the possibility to be applied in many domains (Wacker, 1998). The abstraction of the proposed theory is that ToIE identifies many variables and specifies the relations between them with the basic assumption that the more access to comprehensive and relevant information decision makers have, the more the decision-making process will improve, regardless of the domain in which IE is applied. The scope of this theory focuses on information quality, system quality, perceived benefits, and outcome expectations as motivations for IE among multiple stakeholders to improve decision making. This allows the ToIE to be applicable in different research scopes as long as all the conditions and the boundaries specified by the theory are met.

Table 2. Virtues of a Good Theory (Wacker 1998), and the Virtues of ToIE

<table>
<thead>
<tr>
<th>Virtue</th>
<th>Definition</th>
<th>ToIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniqueness</td>
<td>Differentiated from other theories</td>
<td>ToIE applies to IE which differs from any other kind of exchange.</td>
</tr>
<tr>
<td>Conservatism</td>
<td>New theories cannot replace existing theories unless they are better</td>
<td>Although different theories have been used to address IE, ToIE is new because it has been developed specifically for the IE domain to improve decision making. ToIE is not meant to replace these theories, however if ToIE shows better results, it could.</td>
</tr>
<tr>
<td>Generalizability</td>
<td>The possibility to apply the theory to a different environment</td>
<td>ToIE applies to many environments so long as it is related to IE among multi-stakeholders.</td>
</tr>
<tr>
<td>Fecundity</td>
<td>The ability of the theory to introduce new areas of investigation</td>
<td>ToIE will provide new areas of investigations, such as the impact of unique and common information on improving the decision-making of each participating stakeholder. These investigations can be applied in different IE contexts.</td>
</tr>
<tr>
<td>Parsimony</td>
<td>The simpler the explanation and the fewer assumptions a theory has, the better theory it becomes</td>
<td>ToIE has a simple and straightforward definition and it has limited assumptions.</td>
</tr>
<tr>
<td>Internal consistency</td>
<td>The theory identifies possible relationships between variables and provides enough explanation</td>
<td>ToIE logically explains the possible relationships between the identified variables and “predicts the subsequent event” using the symbolic logic of the deductive method.</td>
</tr>
</tbody>
</table>

Based on theory definition, theory components, and the virtues of a good theory, ToIE provides a clear logical explanation and definition, maintains the theory components, and preserve the virtues of the good theories.

### 4.3 Implications of ToIE

The proposed Theory of information Exchange (ToIE) represents significant contributions to IE research in IS by bridging the gap of IE in information research with both theoretical and practical implications.

From the theoretical point of view, the ToIE fills the literature gap of the absence of theory that explains IE behavior among multiple stakeholders with the goal of improving their decision-making process. Moreover, ToIE provides a comprehensive explanation for the antecedent motivational factors that are necessary for the success of IE among multi-stakeholders. ToIE includes two new constructs, unique and common information, which are unique in the context of information exchange among multi-stakeholders to improve the decision making of each participating stakeholder. This is different from prior studies in IE where the purpose is to reach a consensus or an optimal decision among all stakeholders as highlighted by Dennis (1996). Further, ToIE provides new insights into relationships between the antecedent motivation factors and different types of information, and how they would impact the quality of the decision.

The ToIE also makes practical contributions that provide insights on how to design information systems to facilitate information exchange and the decision-making process in a multiple stakeholder environment. Chapter 5 explains how ToIE is used to build an Information
Exchange Decision System (IEDS) framework that provides guidance to developers and professionals to design IE platforms.
Chapter 5. IEDS Framework

As discussed earlier, there is no existing framework or formal process that guides the design of an IE platform to facilitate IE among multiple stakeholders to improve their decision making. This chapter addresses this literature gap by presenting an Information Exchange Decision System (IEDS) framework based on the ToIE proposed in Chapter 4. The aim of the IEDS framework is to provide a formal process/guidance that helps designers to build the IE platform to support the decision-making process of different stakeholders. Therefore, this chapter addresses designing the IEDS framework building on the proposed ToIE and provides the crucial steps that allow for a successful IE between stakeholders to improve their decision process. This chapter answers the second research questions of this dissertation: “what is the formal process (framework) that can guide the design of an IE platform for multiple stakeholders to improve decision making?”

The ToIE includes three assumptions that the IEDS framework needs to meet: (1) there are multiple stakeholders interested in participating in Information Exchange, (2) each stakeholder has their unique information to be exchanged, and (3) multi-stakeholders would use an IE platform to access the common information. To satisfy the first assumption, the IEDS framework should include the identification of the relevant stakeholders who want to exchange the information among them. For the second assumption, the IEDS framework should provide functionalities to elicit unique information from different stakeholders. For the last assumption, the IEDS framework should include design guidelines for how to design a system for effective IE between multi-stakeholders to improve their decision-making quality. Thus, the proposed IEDS framework includes 4 steps as shown in Figure 3. Below I describe each step in more detail.
Step 1: Identify the stakeholders

As shown in Figure 3, the first step in the IEDS framework is to identify the stakeholders who would participate in IE and who hold unique information that has value to all other expected participating stakeholders. McGrath and Whitty (2017) define stakeholders in terms of their interest and their work activity, whereas the business dictionary website defines “stakeholders” 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 (as cited by Sharp et al. 1999; Pouloudi and Whitley 1997)); whereas Cleland (1985) defined stakeholders as any person or organization that has an interest in the outcome of a project (as cited by McGrath & Whitty 2017)).

Although these definitions provide a broad guidance for defining stakeholders, when it comes to a practical problem of identifying stakeholders, none of these definitions are very helpful or provide a concrete approach for identifying stakeholders for a specific project (Sharp et al. 1999;
Pouloudi and Whitley 1997). Thus, some researchers have attempted to provide practical approaches to identify stakeholders. One approach is called “stakeholder analysis” that builds on a social network of recommendations in which one stakeholder is identified and then they are asked for recommendations to identify the next stakeholder and so on (Lim et al., 2011). 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). The third approach is the one that is proposed by Pouloudi and Whitley (1997) in which they suggested four principles for stakeholder identification. These principles are the contingency of the context of stakeholders, inter-relations among stakeholders, the possible change over time, and the political issues that underpin each stakeholder.

By combining all these definitions, three main characteristics of stakeholders were identified; interest in a group or work, has an affect or is affected by a group, or a combination of both (McGrath & Whitty, 2017). Based on these definitions and characteristics, identifying stakeholders will be based on their interest in the type of the project, their effect on the project outcomes, or the impact of the project outcomes on them. It is important to mention that the purpose of IEDS is not limited to increase the business value or profit. Rather, its main purpose is to improve the decision-making process of different or non-relevant stakeholders from different domains. Therefore, the discussion henceforth will focus on the work of the nonprofit sector to highlight the applicability of IEDS on improving the decision-making process.

For example, suppose that one humanitarian organization wants to do some work in a certain country, such as distributing goods or medical supplies for needy people. Based on the IEDS framework, the first step is to identify the stakeholders within that domain. In this example of the humanitarian organization, the stakeholders could include the government of that country,
other humanitarian organizations who already are working in that country, and the people who are the subject of receiving the subsidies. Those stakeholders should be identified based on their interest in the project, their direct effect on the project, or the consequences of the project on their regular work.

Building on social exchange theory, people engage in certain social behavior to maximize benefits and reduce costs (Lin & Chang 2018) and to get some kind of rewards (Zheng et al. 2013). For those people (stakeholders) to participate in social activity, they need to have a common interest in the activity that they are engaging in, which will allow them to maximize their benefits and get some reward. Based on the definition of the theory of social exchange “a joint activity of two or more players when each actor possesses and may offer something valuable from the other actors’ perspective” (Serenko & Bontis 2016), in order for the exchange behavior to be successful, participants need to exchange something that has a value from the other participants’ perspective.

By building on the ToIE, when one of the identified stakeholders share its unique information (e.g., a humanitarian organization, other stakeholders, such as the government or the other humanitarian organizations), the other stakeholders will feel obligated to share their unique information as well. This commitment of each stakeholder to share their unique information will be motivated by perceived benefits and outcome expectations factors that are specified by the ToIE. Because all the identified stakeholders have a direct interest, have an impact, or are impacted by the success of the project at hand, perceived benefits and outcome expectations will motivate stakeholders to continually exchange their information for the sake of the overall success of the project. 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 the needed information

After identifying all stakeholders who have a common interest in IE, it is important to satisfy the second TolIE assumption, which is to identify the needed information that is required for information exchange. Based on the information status, information can be classified into three categories: common information, unique information, and partially shared information (Dennis et al. 1998).

According to TolIE, when stakeholders share their unique information, the unique information from different stakeholders will be aggregated to represent "common information". Therefore, the more unique information that is exchanged between stakeholders, the more access to common information they will have. 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 “common information”, and what the contribution of each stakeholder “unique information” to reach the overall “common information”. Therefore, in this step, we need to identify the needed information that each stakeholder needs to improve its decision and specify who will supply this information.

The process will be as following: each stakeholder will share their unique information by entering them into the system. The system will collectively aggregate the information entered by every stakeholder and present it in a way that identified by stakeholders “common information”. The common information will then 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. Thus, the quality of the decision is better when group members have access to common information than the two other types of unique or partially shared information (Dennis 1996).
For instance, by going back to the humanitarian organization example, the second step, after the stakeholders were identified, is to decide on the needed information that all stakeholders need to support their decision. The needed information (common information) could include demographic information, economic status, health information, the subsidies already distributed there, and the number of people who received subsidies versus those who did not. After identifying the common information, the next step is to decide where the needed information will come from. This includes the contribution of each stakeholder (unique information) to reach the identified common information. For instance, the government might provide demographic and health information; the other humanitarian organizations might provide information about the work they have already done; the people might provide information about their needy status and their overall situation. It is important to highlight that the identified common information contributed by stakeholders should be always revisited and evaluated from time to time to see if there is something missing.

**Step 3: Design the IE system for information exchange**

After identifying all the needed information to be exchanged, it is important to satisfy the third ToIE assumption, which is to have an IE system. Therefore, the third step of the IEDS framework is to design the IE system that allows each stakeholder to share its unique information and incorporate it with other stakeholders’ information to represent the common information. In this step, we need to decide on what systems, technologies, or tools will allow stakeholders to share their unique information easily and seamlessly. Different technological options should be evaluated in order to come up with the best technological one. For instance, each stakeholder, such as a government or humanitarian organization, will use an information entry page to contribute its
unique information. The system then will integrate the overall entered information and presents it in a way that was agreed upon by all stakeholders “common information”.

However, according to ToIE, any technology that is chosen to build the information exchange system should maintain two things: the quality of the exchanged information, such as information format, accuracy, and sequence (Moberg et al. 2002); and the quality of the system, such as the ease of use, the time and effort required (Hilmer & Dennis 2000) or interactive visualization (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012), such as navigation, filtering, or selection (Conati et al., 2014). Information quality and system quality are the main components that users use to decide on whether to continue using a particular system or not (Swanson 1982, as cited by Davis 1989).

Returning to the ongoing humanitarian example, the selected system should be able to present the information in a specific format in terms of font size, color, and so on; should be able to present the timeline of the shared information where participants can trace back the information; should be easy to use in which there is no extra effort required to share or engage with content; and should be able to visualize and present the information clearly and compellingly (Miller et al., 2012). For instance, when stakeholders enter their unique information into the system, the system will present the common information in standardized format in terms of font, color, etc. the system will allow the stakeholders to trace back the information to see whether the information is updated or not; the system also will visualize the common information that is identified by stakeholders in an easy way where no special effort is needed.
Step 4: Implement the IE system

The final step in the IEDS framework is to implement the selected system (step three) that facilitates the exchange of information between the participating stakeholders. The implemented system should maintain all the above-identified factors that motivate participants to exchange their unique information. To ensure this, we need to test the system to see whether information quality and system quality factors are maintained in the designed system because the overall success of the IE behavior will depend on the quality of these two factors. If there is a discrepancy in the information format or if there is an extra effort required by users to deal with the system, then the IE will not be successful (Moberg et al. 2002; Hilmer & Dennis 2000).

It is important to highlight that these steps of the IEDS framework are iterative which means that after implementing and using the IE system, the system designers should go back to the first step and check the participants’ common interest and the value of the shared information, evaluate the effect 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 meet its initial goal of information exchange to support decision making.

Referring back to the humanitarian example, if the stakeholders identified their common information, and were committed to sharing their unique information using the designed system, then the system will present the common information that satisfies all the participating stakeholders and improve their decision-making process. For instance, the humanitarian organization could easily decide on where to provide its subsidies, prevent the conflict or duplication with other organizations, and anticipate how many people to serve. The government would be able to keep track of the need of its own people and organize the work between different
humanitarian organizations. Finally, the people would be able to reach specific organizations based on their needs such as food, medicine, shelter and so on.

In the next chapter, the IEDS framework is evaluated using a case study of three main stakeholders who are interested in information exchange to make decisions. An IE platform is developed to evaluate the effectiveness of the framework in facilitating the IE between stakeholders.
Chapter 6. IE Platform Implementation and Evaluation

This chapter presents a case study that describes the design, the implementation, and the evaluation of the IE platform to support the decision-making process of different stakeholders. The IE platform design and implementation are guided by the IEDS framework. This chapter answers the third research question of this dissertation: how can the IEDS framework be instantiated to provide IE for multi-stakeholders and improve their decision making? The IE platform is an instantiation of the IEDS framework. The successful implementation of the IE platform demonstrates the framework’s feasibility and the evaluation of the IE platform demonstrates the framework’s effectiveness.

The rest of this chapter is organized as follows. Section 6.1 describes the case study background, followed by Section 6.2 that specifies the design and implementation of the IE platform using IEDS as a guideline. Section 6.3 evaluates the IE platform and its impact on the decision making of different stakeholders. Section 6.4 evaluates the IEDS framework.

6.1 The Background of the Case Study

The case study focuses on a problem related to the education system and its linkage to market needs in a middle-east country. Over the past few years, the number of students studying abroad from the country has increased dramatically. At the same time, there is also an increasing number of non-profit organizations that provide fully funded scholarships to qualified students.

Currently, each scholarship organization makes its own decisions based on the information that they have (unique information) without information of what other scholarship organizations are doing or what the market needs. Similarly, students do not have access to information about the market needs to support their choices of academic majors and future career goals. Moreover,
employers do not have access to any information about qualified and graduated students whom they can recruit to fill their job needs, which has resulted in either recruiting unqualified people or bringing qualified people from overseas. Therefore, there is a need to exchange information that is related to what academic majors current students have and what the market demands. Such an information exchange would not only support the scholarship organizations’ ability to strategically place students in different areas based on market demand, but also allows the students to better select areas of studies. This would result in a balanced supply (different areas that students would study) and demand (different areas that the employers would need).

To solve this problem, the IEDS framework is used to design an SES-IE (Students, Employers, and Scholarship Information Exchange) platform that allows the exchange of information among students, scholarship organizations, and potential employers. This platform serves three main objectives:

1. Provide guidance for students to choose their majors and support that decision-making process.
2. Assist scholarship organizations in the process of rationalizing scholarship programs by focusing on specialties in which there is a shortage.
3. Assist the public and private sectors in selecting qualified students to recruit, as well as assisting students in obtaining jobs in their area of specialization.

The idea underlying this platform is that each stakeholder has unique information that other stakeholders might need to make their decision. Therefore, based on ToIE theory, to make this platform more effective, each stakeholder needs to share its unique, but not sensitive, information and make it common to others so they can use it for their needs.
This platform links different stakeholders through one platform and provides multi-purposes to different stakeholders to speed up the process of taking the required actions. The platform will allow different stakeholders to look at different information based on their needs and have a comprehensive overview. For example, scholarship organizations can look at the number of students in each major and decide on which majors they should focus on, employers can look at the graduated students in their preferred majors and decide how to attract them for recruitment, and students can find suitable recruiters and sponsors.

### 6.2 Steps to Build the SES-IE Platform

This section illustrates the usage of the IEDS framework steps to build an SES-IE platform to support the decision making of multi-stakeholders. As explained earlier, there are three assumptions addressed by ToIE theory and explicitly presented in the IEDS framework. These assumptions are the existence of multi-stakeholders, the exchange of unique information, and the use of the IE system to get the common information. This case study of an education system is used to reflect on all the IEDS steps that are needed to build the SES-IE platform. Figure 3 reminds the reader of the IEDS process steps.
Step 1. Identify the Stakeholders

According to the IEDS framework, the first step to build the SES-IE platform is to identify the expected stakeholders. Identifying stakeholders will be based on their interest in the outcome of the IE and the possession of unique information that has value to all expected participating stakeholders. Identifying stakeholders will be based on their interest in the type of the project, their relationship to the project outcomes, or the impact of the project outcomes on them. Based on the case study at hand, three main categories of stakeholders were identified including scholarship organizations, employers, and students (SES). Recall that the outcome of the IE project here is to improve the decision-making process of the identified stakeholders.

Identifying stakeholders follows a combination of two main approaches; the first one is the “stakeholder analysis” approach (Lim et al. 2011), which is based on the social network of recommendation in which one stakeholder is identified and then asked for recommendations to identify the next stakeholder and so on. For example, I started with the scholarship organization
as one main stakeholder and then asked them to identify another stakeholder whom they believe holds very important information that is beneficial to support their decision. The second approach is to identify stakeholders based on the expected work that is supposed to be done and their level of participation (Sharp et al. 1999). Using this approach is very handy to remove the inactive stakeholders who were identified using the first approach and keep only the ones who know exactly what their role is.

After identifying the stakeholders, it is crucially important to look at the factors that motivate each stakeholder to share their unique information and actively participate in the IE behavior, because stakeholders need some motivation to keep them committed to exchange their information. ToIE theory and the IEDS framework specify that perceived benefits and outcome expectations are the main factors that will increase the commitment of participating stakeholders to exchange their information. To maintain this commitment, each stakeholder should know exactly the benefits and the expected outcomes of participation in this IE. Because all the identified stakeholders have a direct interest, have an impact, or are impacted by the success of the project at hand, perceived benefits and outcome expectations will motivate stakeholders to continually exchange their information for the sake of the overall success of the project. Table 3 summarizes the perceived benefits and outcome expectations for the three stakeholders.
Table 3. Perceived Benefits and Outcome Expectations for the Three Stakeholders

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Perceived Benefits</th>
<th>Outcome Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholarship Organizations</td>
<td>▪ Access to more information</td>
<td>▪ Enriching their knowledge (e.g., knowing what and how other organizations are doing)</td>
</tr>
<tr>
<td></td>
<td>▪ Recognition (e.g., by providing more scholarships)</td>
<td>▪ Increase the reputation</td>
</tr>
<tr>
<td></td>
<td>▪ Better-utilizing resources (e.g., reduce the cost, effort, and time)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Organizing the work between scholarship organizations and rationalizing their scholarship programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Remove the work duplications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Reduce the overhead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Better serve the community</td>
<td></td>
</tr>
<tr>
<td>Employers</td>
<td>▪ Access to more information, recognition (e.g., by providing more job opportunities)</td>
<td>▪ Enriching their knowledge (e.g., knowing what and how other organizations are doing)</td>
</tr>
<tr>
<td></td>
<td>▪ Better-utilizing resources (e.g., reduce the cost, effort, and time)</td>
<td>▪ Increase reputation</td>
</tr>
<tr>
<td></td>
<td>▪ Reduce the overhead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Better serve the community</td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>▪ Access to more information</td>
<td>▪ Social support (e.g., connecting with other students, scholarships, and employers)</td>
</tr>
<tr>
<td></td>
<td>▪ Better-utilizing resources (e.g., reduce the cost, effort, and time)</td>
<td></td>
</tr>
</tbody>
</table>

Step 2. Identify the Needed Information

Once the stakeholders are identified, the second step is to identify the needed information for each stakeholder and specify from where this information will come. To identify the needed information, a focus group discussion was conducted with highly knowledgeable representatives in leading positions from different stakeholder groups, including scholarship organizations, employers from the public and private sector, and students. Nine individuals attended the focus group discussion: four from scholarship organizations (including a CEO and a Board member), three employers (from government and private sectors), and two students (Ph.D. and Master’s). The group discussion took about one hour. The meeting started by illustrating the problem that the
researcher was trying to solve and highlighting any shortcomings or obstacles in the scholarship programs and the recruitment process relating to the lack of information for decision making.

The main point of the discussion was to learn about what kind of information stakeholders need from other stakeholders that will be beneficial to improve the process of making a decision. This question allowed me to identify the stakeholders’ roles to provide the needed unique information. For example, one employer said that

finding a qualified person is always a challenge for us. I knew that the scholarship programs are doing a great job, but when I want to recruit someone, it is very hard to locate them, which forces us to look for qualified people outside the governorate or even the country.

A scholarship organization member said that

we lack more detailed statistics such as the number of students studying in different majors and sponsored by different organizations, students’ gender differences with respect to majors and countries. Also, we need to know employers’ jobs and needs, which can help students to see market needs trends in a way that will both help students to get a job.

Each stakeholder needs some information to guide their decision. This information includes, for example, the number of students in each major and in each country, the number of graduate students who find a job or not, the number of students sponsored by each organization, and so on. At the end of the group discussion, I saw a clear picture of the identified stakeholders and specific unique information that every stakeholder needs to provide (as explained in Table 4).
Table 4. The Needed Information of the Three Different Stakeholders

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Needed information</th>
<th>Source of the information</th>
</tr>
</thead>
</table>
| Scholarship organizations| - The overall number of students studying in different majors and sponsored by different organizations (Partially shared information)  
                          | - The market needs for recruitment. (Unique information)                             | - Students                |
|                          |                                                                                     | - Employers               |
| Employers                | The availability of graduated qualified students. (Unique information)               | - Students                |
| Students                 | - The available scholarships. (Unique information)                                    | - Scholarship organizations|
|                          | - The available jobs in the market. (Unique information)                             | - Employers               |
|                          | - The density of students in each major. (Partially shared information)               | - Students                |

Combining all the needed information will represent the common information

Table 4 shows the three types of identified stakeholders and the information needs of the three different stakeholders. By aggregating all the needed information (unique and partially shared information) from the different sources, I was able to create common information that will serve the different stakeholders. At the end of this step, stakeholders can envision what the common information will look like after building the platform. Common information is basically aggregating all the unique information, organizing it, and then making it available to all participating stakeholders which will allow them to have a comprehensive view of new and relevant information that is not known to them before, and that they can use for their decision making. After identifying the needed information and its source, the third step is to design the IE system that maintains exchange of the information and the presentation of common information.

Step 3. Design the IE System for Information Exchange

This step is to design the IE system. According to the IEDS framework, the core meta requirements that are generic to any IE platform are information quality and system quality. The
information quality factor represents the ability of the IE platform to standardize the information format, such as font size and color, accuracy, and timeline; whereas the system quality factor represents the ease of use of the platform, that is, it requires no extra effort is required for users to use the platform, and it provides the ability to visualize the information in an interactive way. In this case study of the identified stakeholders, based on the design requirements, the SES-IE platform needs to be able to exchange the information between the different stakeholders (e.g., Each Stakeholder will have a specific Form entry to exchange unique information), provide location-enabled features, and present and visualize the common exchanged information. These requirements allow stakeholders to easily and seamlessly share their information and present the common information in an interactive way (see Figure 4).

![System Requirements Diagram]

*Figure 4. System Requirements*

A search was performed to evaluate different technologies and identify the most appropriate technology that meets the above design requirements to design the SES-IE platform.
Esri’s ArcGIS Insights, Dashboards and Survey123 tools were found to be the best options that provide the necessary features and functions. These features include the ability to involve different stakeholders on one platform, the opportunity to utilize location features, and the capability to present the data interactively and visualize it in a way that facilitates the decision-making process. Survey123 provides form entry for information exchange, ArcGIS maps enable location features, and Insights and Dashboards enable the presentation and visualization of information.

Esri’s ArcGIS tools will maintain the two core requirements of IE: information quality and system quality. The system quality factor will be achieved in terms of the ease of use of the platform, where no prior experience is required for users to visualize the information in an interactive way, and easy navigation and filtration of the information. The information quality factor will be achieved in terms of the ability to standardize the information format, such as font size and color, and specify in advance what information can be shared by every stakeholder and how this information will be presented.

<table>
<thead>
<tr>
<th>Stakeholders (unique/partial information)</th>
<th>Present information to groups (common info)</th>
<th>Make the decision</th>
</tr>
</thead>
</table>

*Figure 5. The Flow of the Process*

As shown in Figure 5, each stakeholder, such as a scholarship organization, will use an information-entry page to share its unique information. The system will present the common information in standardized format in terms of font size, color, and so on; will allow the stakeholders to trace back the information to see whether the information is updated or not; and will visualize the common information that was identified by stakeholders in an easy way where no special effort is needed.
Step 4. Implement the IE System

The last step in the IEDS framework is to use the identified technology that met the system design requirements to build and implement the IE platform. In this case study, different components of the Esri ArcGIS suite are utilized because the survey 123 tool from ESRI is used for stakeholder’s data entry, where each type of stakeholder uses a separate web form to share their unique information. ArcMap is used to aggregate all the shared information from different stakeholders and present it on a map. Additionally, ArcGIS insights and dashboards are used to build the information visualization and to present the common information. Finally, StoryMaps and web builder are used to build the platform. In the rest of this section, I explain the design of how these tools are implemented.

1. Stakeholders’ Data Entry

To exchange unique information, I designed three data entry web forms (see Figures 6, 7, and 8), one for each type of stakeholder, to capture their unique information. Each web form has pre-specified the needed information identified in step 2.
Figure 6. Student IE Form
Figure 7. Scholarship IE Form
Figure 8. Employer IE Form

Data from 100 students, 10 scholarship organizations, and 10 employers were collected and added to the IE database. After making sure that all components of the system worked correctly for a subset of stakeholders, three feature layers, one for each web form, were created to link the data with its location.
For example, when a scholarship organization announces a scholarship, the feature layer automatically identifies the location of that organization based on the entered data. Then, a web map 1 (see Figure 9) was created to link the three feature layers together and create common information. The purpose of creating a web map is to combine all the information from different data entry forms in one map, provide better visualization for the shared information based on the locations, and provide interactive search by zooming into the map and showing only the relevant information.

Moreover, the web map is used later as a base for building the dashboard in which all the visualized information is fed from the web map. To organize the information and maintain the information quality requirement, I configured the pop-up message for every feature layer in which only the relevant information will appear when the user clicks on any point on the map. See Figures 10, 11, and 12.

Figure 9. Web Map 1 of All Stakeholders
When the user clicks on any point in the map, a pop-up message will appear showing the total number of students in that country (see Figure 10), a brief description of the available job (see Figure 11), or scholarship (see figure 12) with their contact information.

A map shows different symbols for each stakeholder (see Figure 9, which shows a map of all stakeholders). By clicking on the symbols on the map, users can easily identify the locations of the students, available scholarships, and the available jobs. The web map is set up for a one-minute interval refresh, meaning that the map will have virtually up-to-date information every minute. This web map, which contains all the exchanged information from all stakeholders, will be used later in designing the dashboard to visualize the common information.

Figure 10. Pop Up Configuration for Countries
To avoid duplication of the information and to maintain the visualization system requirement, I created another web map that contains the information from scholarship organizations and employers feature layers. The purpose of doing this is to visualize the information from different perspectives and provide more insightful information as explained.
below. This web map is used later on to visualize the available scholarships and the available jobs in a separate dashboard, which makes it easier for users to find what they are looking for.

Similar to the previous web map, in this web map I configured the pop-up and the symbols and made it consistent with the previous web map to maintain the information quality requirement.

![Image of web map](image)

*Figure 13. Web Map2 For Scholarship Organizations and Employers*

2. **Dashboard Visualization**

Once the web maps are designed and tested for their functionality, they were migrated into a dashboard for visualization. The Esri Dashboard app was used to design two dashboards: the common information dashboard, and the jobs/scholarship vacancies dashboard. Instead of having all the information in one dashboard, the information was split into two to make it easier for users to find the information that they are looking for. The design of the two dashboards is explained below. The map in this dashboard is interactive in which if a user wants to see only the students in a specific country, he or she can zoom in to that country and all the graphs will be updated accordingly.
2.1 Common IE Dashboard

This dashboard brings the information from the web map of all stakeholders and visualize the common information that every stakeholder may need (see Figure 14). This dashboard shows all the information shared among the three types of stakeholders. Six different types of information were presented, and grouped by the aggregated number of enrolled and graduated students, by country, by specialization, by location, by gender, and by scholarship organizations. For example, the dashboard shows the total number of students enrolled in education and the total number of graduated students, as well as the total number of students in each country with respect to their degree programs (Bachelor’s., Master’s., and Doctoral).

![Common Information Dashboard](image)

*Figure 14. “Common Information” Dashboard*

From these graphs, stakeholders can easily identify where most students are located, as well as their degree programs. Moreover, the dashboard shows the total number of students in each major with respect to their degree programs. This gives stakeholders the ability to recognize easily the academic majors that receive many students versus the academic majors that have a shortage.
of students, which can be used to rationalize the scholarship program and focus on the majors that have a shortage.

Similarly, the dashboard provides the same statistics of the academic majors but with respect to gender differences in each major. This gives the stakeholders the ability to see the academic majors that are attractive to each gender or both. This will be helpful for scholarship organizations if they want to diversify between males and females in each major. It is also helpful for employers who have a preference for a specific gender to fill a job vacancy. The other graph counts the number of students per city who secured a scholarship with respect to gender differences. This is very helpful for scholarship organizations if they want to apply the social justice concept and balance between the number of students in each city who get a scholarship.

2.2 Jobs/Scholarships Dashboard

The second dashboard shows more details about the job and scholarship vacancies. The information in this dashboard is also fed from a web map2 (see Figure 15). This dashboard shows all the information shared by scholarship organizations and employers. Six different types of information are presented, and grouped by the total number of available scholarships, the total number of available jobs, the deadline of the available jobs and scholarships, the list of the available jobs and scholarships, and the interactive map. For example, the left side of this dashboard shows the current total number of available scholarships and jobs. These numbers adjust automatically when the deadline for any scholarship or job is passed. The dashboard also arranges the available scholarships and jobs in order based on their deadline.
The user can view the available scholarships and jobs either by their deadline or as a list. Whenever an available scholarship or job is selected, a pop-up message will appear on the map showing some relevant information such as the organization or company name, the deadline to apply, the website URL, and the email address. The map here is also interactive in which users can specify their preferred location on the map to find scholarships or jobs.

Both dashboards account for information quality in terms of the format, such as font size, color, etc., and the timeline in which the user can trace back the information including the deadline. Besides, the dashboards also account for system quality in terms of ease of use and required effort, in which the user needs only to use the mouse to explore the platform and to navigate throughout the dashboards. Moreover, the dashboards embrace the dynamic visualization technique in which users can filter the information by selecting a specific factor, such as an academic major or a country, and all the information will be updated.
3. Interactive Statistics Page

The Insights tool in Esri’s ArcGIS provides more opportunities to look at the information from different perspectives to gain more insightful ideas. Using Insights, users can attain access to an interactive report that has summary statistics and can drill down and roll-up. The interactive statistics report shows the total number of students in each university across the globe with respect to academic level, gender differences, scholarship organizations, and country (see Figure 16).

For instance, by clicking on the Bachelor’s students in Malaysia, on the top right graph, the three other graphs will be updated automatically to show the information accordingly. The top-left graph will show the universities where all the Bachelor’s students are enrolled plus the number
of students at each university. The bottom left graph will show the total number of students in that country with respect to their gender. Finally, the bottom right graph will show the scholarship organizations sponsoring those students in that country and identify the self-sponsored students.

The interactive statistics page represents visualizations to interact with the data, which allows stakeholders to dive deeply into the shared information and gain some insights that could improve their decision making. For example, a student who is granted a scholarship to a certain country can use this interactive page to see whether there are some students already in that country. Similarly, scholarship organizations can easily see the distribution of the students in each country, who are sponsored by different organizations, with respect to their academic level, gender, and university, which can be used to organize their scholarship programs. Likewise, employers can use this page to get information about students in a particular country or a particular university to support their decision about recruiting qualified students. Like dashboards, the interactive page updates automatically once the information is shared by a stakeholder.

4. StoryMaps and Web Builder

After designing the data entry forms, the web maps, dashboards, and interactive statistics page, these components were combined in one platform. StoryMaps and web builder were used to integrate all the components, which work as a container or a template that brings different components into one platform and links them together in an interactive and user-friendly way (see Figure 17).
The SES-IE platform has five main tabs. The first tab provides an overview of the SES-IE platform and it provides links to the data entry forms for the three types of stakeholders: Students, Employers, and Scholarship organizations (S.E.S). The second tab displays the common information dashboard, whereas the third tab presents the jobs/scholarship vacancies dashboard. The fourth and fifth tabs provide access to the interactive statistics page and the designer contact information, respectively.

The SES-IE platform has a public-facing component that every stakeholder uses to access the information. The logic of accessing the SES-IE platform is as follows: the identified scholarship organizations and employers, who agreed to exchange their information, will be given access to all components of the SES-IE platform for which no prior registration is required. This is because when organizations or employers share their information their names will appear on the SES-IE platform, which will increase their recognition and reputation in the community. These two factors, in addition to the other factors of perceived benefits and outcome expectations,
represent internal motivation for stakeholders to exchange their information as explained above in the IEDS framework and the ToIE. If one of the stakeholders is not active in exchanging its information, then the stakeholder's request to access the SES-IE platform will be denied.

For students, the process is a bit different. Students' names will not appear on the SES-IE platform; therefore, the recognition and reputation factors for individuals might not clearly exist here. To encourage many students to register and exchange their information, students are initially given access only to the data entry form. However, once a student registers and submits his/her information, then he/she is given access to the other components of the SES-IE platform. To keep the data up-to-date, students will be asked to update their information at least once a year in order to maintain access to the SES-IE platform.

Designing the story maps represents the last step in building the SES-IE platform. The SES-IE platform maintains the two important factors that motivate IE, information quality and system quality. The platform also meets the system requirements identified above in terms of maintaining information exchange, identifying the location, aggregating the information, and utilizing easy to use visualizations. The platform is designed to be explored and navigated using only a mouse or a finger (for touch screen devices). Therefore, no data entry is required to explore the platform; however, data entry is required only when the stakeholders fill out the data entry form to exchange their information.

In the next section, I evaluate the SES-IE platform using a mixed-methods approach.
6.3 The SES-IE Platform Evaluation

The evaluation cycle is considered a crucial part of DSR because otherwise, the research method will be incomplete. In this study, the effectiveness of the SES-IE platform is evaluated using a mixed-methods approach. The qualitative analysis was conducted through interviews and focus group discussions, and the quantitative analysis was conducted through an online survey.

6.3.1 Qualitative Evaluation

Using a snowball sampling approach, several semi-structured interviews and focus groups were conducted to collect data from 40 highly knowledgeable participants (18-65 years old) in leading positions from different stakeholder groups including 9 scholarship organizations (including CEO, Board member, founders), 4 employers, and 27 students (Ph.D. and Master’s). Table 5 below shows the number of participants in interviews and focus groups.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th># of Interviews</th>
<th># of Focus Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholarship organizations</td>
<td>5</td>
<td>1 (total of 4 participants)</td>
</tr>
<tr>
<td>Employers</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Students</td>
<td>1</td>
<td>6 (total of 26 participants)</td>
</tr>
<tr>
<td>Total</td>
<td>Total of 10 participants</td>
<td>Total of 30 participants</td>
</tr>
</tbody>
</table>

Each interview took about one hour. All interviews are recorded and transcribed. The interview began by illustrating the research problem and the importance of information exchange in improving decision making.
6.3.1.1 Data Collection

In order to evaluate the effectiveness of the SES-IE system, I need to understand the current issues that stakeholders have during the decision-making process, which will make it easier to see whether the SES-IE platform was successfully able to resolve these issues and improve the decision process. I started the discussion with these questions, “What is the current process of making decisions? Do you consider relevant outside information during the process of making a decision?” The purpose of this question is to have a base for benchmarking of the current process.

After that, I demonstrated the SES-IE platform and its ability to solve the highlighted problems and improve decision making. Then, I followed up the interviews with some open-ended questions to get the interviewees’ opinions about the SES-IE platform and to seek their feedback for further improvement. These questions include, “Would you use the system for decision making, and why? What do you think of the data visualization? Coloring? Ease of navigation? Which component helps (Does virtualization help? Does the common information help? How about information quality and system quality)?” and so forth (see Appendix B). The interviews and the focus group discussions were concluded when saturation was reached, that is, where no more ideas emerged.

6.3.1.2 Qualitative Results

The purpose of the qualitative study was to gain more insights about the usability of the SES-IE platform to improve the decision making. For the initial question “What is the current process of making decisions, do you consider relevant outside information during the process of making a decision?”, each stakeholder described different processes based on the nature of their work, scholarship, employer, or student. However, none of the interviewees mentioned anything
about information exchange or having access to other information beyond their organizational boundaries. For instance, a representative of a scholarship organization said:

*When we announce a scholarship opportunity, most of the applicants want to study engineering majors. Usually, the only factor we consider for the scholarship program is whether the student meets the scholarship requirements. All that we care about during the decision process is how to collect the sufficient fund to maintain the student’s scholarship.*

The case is the same for employers. When asked the same question about the decision-making process, one employer said:

*We announce the job vacancy on our website and some social media platforms, such as Facebook. However, few people apply through these means. The majority of the applicants come from a referral from a person who is already working with us. Sometimes we recruit the applicant, not because of his/her qualification and job matches, but because he/she is the only one [who] applied. We do not really have access to qualified people in different majors.*

The burden is more on the students, in terms of time and effort, when looking for a scholarship or job vacancies. Students spent a considerable amount of time moving from one website to another looking for an opportunity. As one student said:

*Looking for a scholarship is a full-time job. I spent a lot of time browsing the local and international scholarship organizations’ websites looking for opportunities. I do not know when these organizations will announce their scholarships; therefore, I need to check their websites almost every day.*
From the responses to the first question, it can be noted that stakeholders usually depend on their internal information (“unique information”) to make their decision with no access, as in the case of scholarship organizations and employers, or partial access, as in the case of students, to other stakeholders’ information (“common information”).

Once the interviewees answered the first question about their current decision-making process, I demonstrated to them the SES-IE platform and how the information can be exchanged and visualized in real-time. The demonstration took about 20 minutes. All participants recognized the usefulness of the platform and were able to realize the importance of accessing comprehensive information and consider it for their own decision process. In addition, participants were able to see the problem of the inability to access comprehensive information during their current decision-making process that lies beyond their control when it comes to dealing with different stakeholders, and noticed how the SES-IE platform helps to solve this issue.

As one stakeholder said:

This is amazing. The platform listed all that we need in one place. This will make our life much easier. We always try to improve our scholarship program by improving the quality of the internal system we have in place. However, now I can see the importance of the openness to other stakeholders and use their information as a basis for our own decision.

Likewise, a student commented that:

This is astonishing! I am glad that your system will help me personally and many others to solve a real problem that we deal with in daily life.

After transcribing all the interviews and group discussion data, a thematic coding (Robson & McCartan, 2016) was used to extract themes from data and organize the participants' comments.
under certain categories. Three main themes emerged from the qualitative analysis: ease of use and simplicity, usefulness, and improving decision-making. All participants touched on these themes during the interviews in terms of the simplicity of the platform, the usefulness of the available information, and the usage of the platform and the information to improve their decision-making. These three themes represent the high quality of the SES-IE platform as explained below.

1- Ease of Use and Simplicity

The SES-IE platform was viewed as simple and easy to use by most of the participants. The qualitative data showed that the SES-IE platform is easy to use in terms of the effort required to use the platform, the organization of the content, the visualization, and the format of the information in terms of font size, colors, etc.

Students were the most excited about the SES-IE platform. All of them agreed that the platform will make it easy for them to apply for scholarships and job vacancies.

*I will definitely use this platform anytime I look for a scholarship or a job. The way that the platform is designed is super simple. I found it easy to filter scholarships or jobs by location. The information is presented in a standardized format and well organized. This will save me a lot of time and effort. From a personal experience, looking for a scholarship is always irritating especially when I use social media. People like to share whatever links come to them. Many times, I end up with inaccurate links or past the deadline. A student said.*
Another student added:

_I don’t need to spend too much time moving back and forth from one website to another looking for an opportunity. The platform organized and visualized the information in a clear, concise, and simple way._

Employers also expressed the simplicity of the system, as one employer said:

_I am really impressed with this system and this is really what we need. The system will add great value to our process. The system provides detailed information and nice visualization. With a single click, we can find all that we are looking for. We will for sure embrace this system._

Similarly, scholarship organizations also viewed the system as simple and easy to use. A scholarship organization representative said:

_I like the way that the platform presents the information. The information is well organized in different tabs. I can easily navigate through the platform and find what I am looking for._

### 2- Usefulness

All participants highlighted the usefulness of the SES-IE platform. The meaning of usefulness differs among different stakeholders. For students, the platform is useful because it allows them to see easily the scholarships and jobs so they can directly apply to them, which saves them time and effort. For scholarship organizations, usefulness means that the organization can collaborate with other organizations to improve and rationalize their programs and save some resources. Finally, for employers, usefulness means that they can attract and recruit the right
qualified candidates to hold the vacant positions, which saves employers some time and effort, and adds value to them.

The majority of the participants clearly state that the system is useful. For instance, a student said:

*This platform will save me a lot of time and energy while looking for a job or a scholarship. The platform has all that I need in one place. Therefore, I don’t need to spend time moving back and forth between different websites.*

Another employer said:

*I think the platform would help us to see whether there are qualified candidates for our vacant positions. This is very useful for us and [I] will definitely use it during our work.*

Scholarship organizations' participants showed not only their interest to use the system but also their willingness to sponsor and fund the implementation of the system in real life. A scholarship CEO said:

*This is amazing, I can’t believe that one day I will see something like this. This system will help us a lot and will make our life much easier. We are ready to embrace this system and provide all means of support, logistically and financially.*

The founder and executive board director of one scholarship organization took a further step and said:

*Right now, we are building a new system to track students’ success and create reports about our alumni. However, I will ask the IT team to stop doing that and let them meet with you and discuss how we can embrace this system.*
3- Improving Decision Making

One of the primary goals of the qualitative study was to gain insights about how the platform will help different stakeholders to improve their decision making. The majority of the participants confirmed their willingness to use the system to improve their decision making. This third theme, improving decision making, is identified as a consequence of the previous two themes. Because the SES-IE platform provides access to comprehensive information (which is often mentioned by scholarship organizations and employers), is simple and easy to use, and provides good visualizations and format (mostly cited by students), participants perceived it as an efficient tool for improving their decisions.

From the organizations’ perspective, scholarship stakeholders confirmed that the platform will allow them to improve their decision making. The CEO of a scholarship organization said:

_We tried before to arrange with other organizations to rationalize the scholarship programs, but our attempt wasn’t successful due to the absence of a clear and systematic method. I believe this system will put us back on track and we can work together with other organizations and plan for the future of the scholarship program._

An employer stated that:

_I will defiantly use this platform during the recruitment process. It will help me a lot to find the qualified candidates based on our predefined criteria._

Students also expressed their willingness to use the platform to improve their decision making, as one commented:
When I look for a scholarship, I visit many scholarship websites and create a file that has the scholarship website, the opening and the closing date of the scholarship, and the requirements of the scholarship. This platform saved me all of this work in a very advanced and simple way. Everything is done for me. I just need to pick the scholarship and I will see all the details. Of course, I am going to use it, why wouldn’t I.

6.3.2 Quantitative Evaluation

In addition to the qualitative evaluation, a quantitative method was conducted to evaluate the usability and the usefulness of, and user satisfaction of with the system. Interviewees were asked to fill out an online questionnaire that was created to encompass three measures: System Usability (SUS), Perceived Usefulness (PU), and User Satisfaction (US), as shown in the Appendix A.

Perceived Usefulness (PU) means “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989, p. 320), whereas User Satisfaction is defined as “the extent to which users believe the information system available to them meets their information requirements” (Ives et al., 1983, p. 785). System Usability is very common in the IS literature to measure the usability of the system using a 10-items instrument developed by Brooke (1996).

All the questionnaire items were previously validated in the literature and were adopted from existing studies; the Perceived Usefulness (PU) and User Satisfaction (US) instrument adopted from Maes & Poels (2007), and the System Usability Scale (SUS) instrument adopted from Brooke (1996). All the instruments assessed used a 5-point Likert scale ranging from 1,
Completely Disagree, to 5, Completely Agree. The questionnaire was approved as exempt by the CGU IRB. Out of the 40 interviewees/focus group members, 30 participants have successfully completed the questionnaire as follows: 22 students, 5 scholarship organizations, and 3 employers.

6.3.2.1 Data Collection

Based on the responses of 30 participants, the quantitative results have confirmed that the SES-IE platform is usable, useful, and satisfactory. Table 6 shows the demographic data of the participants. The majority of the participants were males, 73.3%, while 26.7% were females. The table also shows that the majority of participants (66.7%) were between the ages of 26-35. Students represent 73.3% of the total participants, whereas scholarship organizations and employers represent 16.7% and 10.0%, respectively. Among the participants of scholarship organizations and employers, there were 2 CEOs, 1 consultant, 3 human resources specialists, and 2 scholarships program managers.

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>73.3%</td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>26.7%</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-25</td>
<td>6</td>
<td>20.0%</td>
</tr>
<tr>
<td>26-35</td>
<td>20</td>
<td>66.7%</td>
</tr>
<tr>
<td>36-45</td>
<td>3</td>
<td>10.0%</td>
</tr>
<tr>
<td>56-65</td>
<td>1</td>
<td>3.3%</td>
</tr>
<tr>
<td><strong>Participant Role</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>22</td>
<td>73.3%</td>
</tr>
<tr>
<td>Scholarship Org.</td>
<td>5</td>
<td>16.7%</td>
</tr>
<tr>
<td>Employer</td>
<td>3</td>
<td>10.0%</td>
</tr>
<tr>
<td><strong>Years of Experience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than 1 year</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>1 – 5 years</td>
<td>5</td>
<td>62.5%</td>
</tr>
<tr>
<td>6 – 10 years</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>11 - 15 years</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td><strong>Job Title</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>CEO</td>
<td>2</td>
<td>25.0%</td>
</tr>
<tr>
<td>Consultant</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>HR</td>
<td>3</td>
<td>37.5%</td>
</tr>
<tr>
<td>Program Mgr.</td>
<td>2</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

### 6.3.2.2 Quantitative Results

Cronbach’s alpha and the average variance extracted (AVE) were used to examine the reliability and the validity of the constructs of the questionnaire, respectively. As shown in Table 7, the reliability scores of PU and US were above 0.7, the threshold, which indicates that the scales have an adequate level of inter-item reliability. The average variance extracted (AVE), which measures the level of variance identified by the construct while controlling for the measurement errors, also indicated the validity of the constructs.

Table 7. Cronbach’s alpha, Composite Reliability, and Average Variance Extracted

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Cronbach's alpha</th>
<th>Composite Reliability (CR)</th>
<th>Average Variance Extracted (AVE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU</td>
<td>0.89</td>
<td>0.90</td>
<td>0.76</td>
</tr>
<tr>
<td>US</td>
<td>0.83</td>
<td>0.83</td>
<td>0.56</td>
</tr>
</tbody>
</table>

The main purpose of the quantitative study is to evaluate the usability of the SES-IE platform. The SUS score was calculated as follows: for each response, subtract 1 from each odd items’ value, subtract each even item’s value from 5, then sum all values and multiply the sum by 2.5. After doing that for all participants’ responses, I calculated the overall average score, as shown in Appendix E. The SUS score of the SES-IE platform is 81, which is higher than the 68 SUS threshold. This shows that the SES-IE platform provides high usability for the users as indicated by the high score.
Table 8. Computed Mean of PU and US scores

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Perceived Usefulness (PU)</th>
<th>User Satisfaction (US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Median</td>
<td>4.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.66</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Table 8 shows the descriptive statistics of the two constructs after calculating the overall scores of PU and US by taking the average score of all items in each construct. The scores ranged from 1 (strongly disagree) to 5 (strongly agree). The highest mean (4.5) belongs to PU. This confirms that the participants believe that the SES-IE platform is useful. Furthermore, the user satisfaction mean (4.4) is also high, which confirms that participants were satisfied using the SES-IE platform. Further, 87% of participants confirm that the SES-IE platform is useful, whereas 93% of participants agreed that the SES-IE platform is satisfying to use.

Table 9. PU Computed Mean Across the Roles

<table>
<thead>
<tr>
<th>Your Role</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>4.4</td>
<td>22</td>
<td>0.70</td>
<td>4.7</td>
</tr>
<tr>
<td>Scholarship Organization</td>
<td>5.0</td>
<td>5</td>
<td>0.00</td>
<td>5.0</td>
</tr>
<tr>
<td>Employer</td>
<td>4.4</td>
<td>3</td>
<td>0.96</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>4.5</td>
<td>30</td>
<td>0.66</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Table 10. US Computed Mean Across the Roles

<table>
<thead>
<tr>
<th>Your Role</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>4.4</td>
<td>22</td>
<td>0.60</td>
<td>4.4</td>
</tr>
<tr>
<td>Scholarship Organization</td>
<td>4.6</td>
<td>5</td>
<td>0.41</td>
<td>4.8</td>
</tr>
<tr>
<td>Employer</td>
<td>4.7</td>
<td>3</td>
<td>0.38</td>
<td>4.8</td>
</tr>
<tr>
<td>Total</td>
<td>4.4</td>
<td>30</td>
<td>0.55</td>
<td>4.5</td>
</tr>
</tbody>
</table>

To compare the means of US and PU with respect to different participant groups, Table 9 and Table 10 show that all three types of stakeholders agreed that the SES-IE platform is useful.
and satisfying, with very slight differences between the means. Specifically, 19 students out of 22 consider the SES-IE platform as useful with a mean score of 4.4 and a median score of 4.7.

Similarly, 20 students out of 22 were satisfied with the SES-IE platform with both mean and median scores of 4.4. Furthermore, all participants from scholarship organizations perceive the SES-IE platform as useful with a mean and a median score of 5.0. Likewise, scholarship participants confirm their satisfaction with the SES-IE platform with a mean score of 4.6 and a median score of 4.8. Finally, 2 out of 3 employers agreed that the system is useful with a mean score of 4.4 and a median of 5.0. However, all participating employers were satisfied with the SES-IE platform with mean and median scores of 4.7. All of the above confirms that all three types of stakeholders agreed that the SES-IE platform is useful, and they were satisfied with its usability.

As indicated above, the qualitative and the quantitative evaluation confirms that the SES-IE platform provides high usability, usefulness, and satisfaction to the three types of stakeholders. The evaluation also confirms that the steps of the IEDS framework are very effective in building and designing the SES-IE platform to improve the decision making of multiple stakeholders. Furthermore, the evaluation demonstrates, aligned with the literature, the importance of information quality factors, in terms of format and content, (Moberg et al. 2002); and the system quality factors, such as ease of use, the time and effort required (Hilmer & Dennis 2000), and interactive visualization (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012).

As demonstrated throughout the above discussion, the SES-IE platform met the three objectives, which were introduced in the case study, and successfully achieved them, as confirmed by the participants. For example, for the first objective, which is guiding students to choose their majors and support that decision making process, students mention that the platform allows them
to see the density of students in each major, decide on what scholarships or jobs to apply for, and have some kind of social connection. During an interview, one student said:

_I will definitely use this platform. It will save me a lot of time and energy while looking for a job or a scholarship. In one place, I can find all that I need, which will help me with deciding on what job or scholarship I can apply for”._

With respect to the second objective, which to assist scholarship organizations in the process of rationalizing scholarship programs by focusing on specialties in which there is a shortage, stakeholders confirm this and show their willingness to embrace this system and provide all required support logistically and financially. As one scholarship CEO stated:

_We have been waiting for such a system for a very long time. Due to the lack of access to such information, we have been arbitrary in selecting students, majors, and countries where we send students. I believe it is time to stop this mess and start rationalizing the scholarship programs by embracing this technology to plan for a better future._

Finally, for the third objective, which is to assist the public and private sectors in selecting qualified students to recruit, employers confirmed that the platform will help them to locate the qualified people and attract them for the available positions. One employer said:

_By using the platform, we don’t need to depend on social media announcements or referrals, we can easily take a look at the platform and decide on whether there are qualified people [who] meet our job requirements or not._
6.4 IEDS Framework Evaluation

The open-ended questions of the semi-structured interviews were purposely made to reflect on the IEDS framework factors and their importance. In the qualitative study, to evaluate the IEDS framework I first explained the logic behind building the SES-IE platform as depicted on the IEDS framework figure. Then, I explained to the participants how the IEDS framework is used to identify the stakeholders and the needed information, choose the technology, and implement the system. I also explained the factors considered in each one of these steps. Participants liked the systematic method of building the platform and mentioned that the framework is comprehensive and covers all the relevant and important parts of the decision making process. A scholarship 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.*

When participants were asked about components that they liked about the IE platform, visualization and the content were the most cited factors among all participants. This confirms what is found in the literature about interactive visualization of information as an important factor of system quality because it reduces the required effort to reach particular information and allows users to comprehend the needed information more easily (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012). Other components mentioned by participants included the access to detailed and comprehensive information, simplicity and ease of use, format, and filtration and navigation.
Participants confirmed the importance of expected outcomes and perceived benefits factors of the IEDS framework. For instance, when I asked participants about their expected outcomes and the perceived benefits from using the SES-IE platform, 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 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 mentioned by scholarship organizations is social justice. They mention that the platform will allow them to see the gender differences and the cities of the sponsored students, which will help to focus on the areas that did not receive or were not covered yet by the scholarship programs. Social connection is another expected outcome mentioned by students, in terms of finding students in different countries or universities. A student said:

*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 results of the interviews reflect the literature regarding the importance of motivational antecedent factors to facilitate information exchange that will encourage participants to use the system frequently, and eventually improve their decision making. Different motivational factors
in the ToIE are mentioned by different stakeholders including: information quality (Moberg et al. 2002; Hilmer & Dennis 2000; Zheng et al. 2013; Nicolaou et al. 2013) such as the content and format, system quality such as visualization and ease of use (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012), and perceived benefits and outcome expectations (Lin and Chang 2018; Homburg 2000; Hall et al. 2010; Xiao et al. 2012; Zheng et al. 2013; Cress et al. 2006).

One concern raised by many stakeholders is the accuracy of the information. Their concern was that if one stakeholder shared inaccurate information, how would the system or the framework account for it? Such a concern can be addressed from three perspectives as follows.

First, this platform and framework assume that stakeholders will share accurate information. Validating the accuracy of the shared information is beyond the scope of this research. Future research might address the factors of validating accurate information. As explained in the system design (see Section 6.2, Step 3), there are some areas that the platform can control, such as the data input fields where data must be selected from drop-downs, and data formats (e.g., font size and color). However, there are certain areas that the platform cannot control, such as validating the current information.

Second, the IEDS framework specifies that stakeholders are selected based on the role that they play in information exchange (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.

Third, the platform specifies what information each stakeholder would share (see step 2 of the IEDS framework) and how to share the information. This will reduce the incidence of sharing
inaccurate information. According to the ToIE and the IEDS framework, the accuracy of the information, a factor of information quality, will impact information exchange behavior and the quality of decision making. Therefore, if inaccurate information is shared, it will impact IE among different stakeholders, and participants will not trust the shared information, which eventually will impact their decision making process. Thus, given the scope of this research, if inaccurate information is shared, then neither the framework nor the platform would help information exchange.

In conclusion, the evaluation confirms that the steps of the IEDS framework are very effective in building and designing the SES-IE platform to improve the decision making of multiple stakeholders. To this point, the steps of the IEDS framework can be used by designers to build an IE system to improve decision making. The evaluation shows the importance of the system quality and information quality factors highlighted in the IEDS framework. These two factors are particularly important because users rely on them to decide on whether to continue using a particular system (Swanson 1982, as cited by Davis 1989). Finally, the evaluation highlights the importance of the other two factors of perceived benefits and outcome expectations to identify the relevant stakeholders. When these two factors are not well addressed during the design of the IE platform, 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).
Chapter 7. Conclusion, Limitations, and Future Work

This dissertation aims to understand the information exchange (IE) behavior within IS research. It highlights the gap of existing IE research in IS, investigates the commonly used theories in IE, and identifies factors that motivate IE behavior. This dissertation has three main aims: propose ToIE, develop the IEDS framework, and use the proposed theory and IEDS framework to instantiate an IE platform to evaluate their effectiveness. Based on existing literature, this research develops a theory of information exchange (ToIE) that aims to explain and understand the phenomena of information exchange among multiple stakeholders with a focus on supporting the decision making process and improving an individual’s decision quality. Based on the analytical deductive approach, the ToIE contains six propositions. The ToIE assumes that when people have access to relevant and comprehensive information, the resulting decision will have better quality (Dennis 1996).

The ToIE can be used to understand IE through different types of information systems where their main purpose is to improve the decision quality of multi-stakeholders. The theory specifies the characteristics of such a system to facilitate IE effectively. That is, the information system designed for IE should focus on both the quality of the exchanged information, such as information format, accuracy, and sequence (Moberg et al. 2002), and the quality of the system, such as ease of use, time and effort required (Hilmer & Dennis 2000), and interactive visualization (Hilmer & Dennis 2000; Bajracharya et al. 2018; Miller et al. 2012).

The second area of this research is the design of the Information Exchange Design System (IEDS) framework. This framework provides a step-by-step process for building and designing an information exchange system that facilitates the exchange of information between different stakeholders for the purpose of improving the decision making of each individual stakeholder. The
framework highlights all the important factors in each step that is needed for identifying stakeholders, identifying the needed information for each stakeholder, designing the IE system, and implementing the IE system. These factors include perceived benefits, outcome expectations, information quality, and system quality.

The third area of this dissertation is to instantiate an IE platform based on the steps identified in the IEDS framework. The SES-IE platform, a web-based application, was developed to facilitate information exchange between three types of stakeholders: students, scholarship organizations, and employers (SES) to support their decision making. The purpose of instantiating the SES-IE platform is to evaluate the effectiveness of the IEDS framework in designing systems for information exchange with the purpose of improving the decision making of every participating stakeholder. The SES-IE platform is GIS- and web-based system. It provides interactive visualization and enables stakeholders to easily access comprehensive information that helps them to make their decision. The IE platform is created based on a case study of the scholarship programs and market needs in one Middle-East country.

A mixed-methods approach of qualitative and quantitative studies was used to evaluate the effectiveness of the SES-IE platform and the IEDS framework. The results of the evaluation confirmed high levels of usefulness, usability, and satisfaction among the users. These results also confirm the effectiveness of the IEDS framework in designing the SES-IE platform, which can be used by designers and developers to build the IE system to improve the decision making of different stakeholders.

The dissertation follows the DSR method and its three main cycles: relevance, build and evaluate, and rigor, to design the IEDS framework and the SES-IE platform. The relevance cycle means that this research is intended to solve a real problem in the environment, which is
information exchange to improve the decision making of every stakeholder. The rigor cycle means that this research is based on the theories, models, and best practices tools from the IS knowledge base, and the research outcomes are added to the knowledge base. This research uses factors and theories available in the literature and contributes to the knowledge base of information systems, DSR, information exchange, and decision support systems by proposing a the theory of information exchange (ToIE) and designing two artifacts: IEDS framework and IE platform. Finally, the build and evaluate cycle is maintained in this research in terms of designing the framework and the platform, and then evaluating them using a case study.

This dissertation makes both theoretical and practical contributions. The theoretical contribution of this research is the theory of information exchange (ToIE) that explains the IE behavior among multiple stakeholders with the goal of improving their decision making process. ToIE includes two constructs, unique information and common information, which are new concepts in the context of information exchange among multi-stakeholders. Additionally, the ToIE provides new insights into relationships between the antecedent motivation factors and different types of information, and how they would impact the quality of a decision.

For the practical contributions, this dissertation provides insights on how to design information systems to facilitate information exchange and the decision-making process in a multiple stakeholder environment. The IEDS framework can be applied in different business domains and provide guidance to the designers and developers of IE platforms. The case study also provides practical knowledge on how to apply the IEDS framework in the artifact design and demonstrate the effectiveness of the proposed theory and the IEDS framework in supporting decision making.
For instance, even though the domain of this current case study (the SES-IE platform) is within the education system, the idea can be generalized to other domains such as healthcare, agriculture, relief campaigns, etc. To do this, the steps are to identify the stakeholders in each domain, decide on the needed information and how it can be obtained, and implement the IE system that maintains the identified factors in the IEDS framework. In healthcare, for example, the IEDS framework can be used to design an IE platform to connect patients, medical doctors, and the ministry of health (government office). Patients could use the platform to choose what doctor to visit, and to write a review about their visits. Doctors might use this platform to have an idea about how their patients are doing and the major diseases from which the patients suffer. The ministry of health might benefit from this by identifying how many patients per doctor is in a specific area, and whether there is an epidemic in some areas. This will help the ministry to plan for the right action such as bringing more doctors to the areas that are suffering and decide on what type of doctors to bring based on the illness.

This dissertation is not without limitations. First, the scope of this research focuses only on information quality, system quality, perceived benefits, and outcome expectations as motivations for IE among multiple stakeholders. This is because these factors can be measured and have a significant influence in IE as stated above. Other factors such as environmental, personal, interpersonal, and cultural factors (Matschke et al. 2014) are left for future research. For example, future research may investigate the effect of environmental and personal factors on the exchange of unique information and examine their impact on decision quality.

Second, the proposed ToIE theory and its propositions were evaluated using a qualitative technique by which the researcher identified the virtues of a good theory and reflected that on the proposed theory. Future research may further investigate these developed propositions and design
hypotheses to evaluate the validity of the ToIE by doing a quantitative study that tests the relationships between the factors.

Third, one limitation of this dissertation is that it takes the assumption that stakeholders share accurate information. Future research should look at the factors that control the accuracy of the shared information and apply data quality measurements. Some design considerations may include mechanisms to identify outdated information, identify the stakeholders who share inaccurate information and suspend their participation in the IE, etc. These mechanisms would help to improve the accuracy of the shared information.
References


https://doi.org/10.1515/libr.2010.011


https://doi.org/10.1145/358413.358430


https://doi.org/10.1108/09593840610649989


https://doi.org/10.1016/j.ijmedinf.2018.05.003


Myers, M. D. (2013). *Qualitative research in business & management* (2nd ed.). SAGE.


Zheng, Y., Zhao, K., & Stylianou, A. (2013). The impacts of information quality and system quality on users’ continuance intention in information-exchange virtual communities: An

https://doi.org/10.1016/j.dss.2012.11.008.
Appendix A. Questionnaire of Information Exchange Among Multi-Stakeholders for Improving Decision Making

Part I: General Information

1. Have you finished reviewing the Information Exchange Platform?
   □ Yes  □ No

2. To what extent are you consider your knowledge of Information Exchange Platform?

   | Completely | Completely |
   | Un-experienced | Experienced |
   | 1 | 2 | 3 | 4 | 5 |

3. Would you like to participate in an interview?
   □ Yes  □ No

4. Your email:
### Part II: Survey Questions:

II.I. For each of the following statements, mark one box that best describes your reactions to the Information Exchange Platform

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

1. I think that I would like to use this system frequently

2. I found the system unnecessarily complex

3. I thought the system was easy to use

4. I think that I would need the support of a technical person to be able to use this system

5. I found the various functions in this system were well integrated

6. I thought there was too much inconsistency in this system

7. I would imagine that most people would learn to use this system very quickly

8. I found the system very cumbersome to use

9. I felt very confident using the system

10. I needed to learn a lot of things before I could get going with this system
II.II. Please tick the circle which most closely reflect your impressions about using (IE platform)

Perceived Usefulness (Maes & Poels, 2007)

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Overall, I think the IE platform would be an improvement to support my decision making.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>12. Overall, I found the IE platform is useful for supporting my decision-making process towards information accessibility.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>13. Overall, I think the IE platform improves my performance in decision making</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Perceived User Satisfaction (Maes & Poels, 2007)

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>14. The IE platform adequately met the information needs that I was asked to support.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>15. The IE platform was not efficient in providing the information I needed.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>16. The IE platform was effective in providing the information I needed.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>17. Overall, I am satisfied with the IE platform for providing the information I needed.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Part III: About yourself and your organization

1. Your gender
   □ Male □ Female

2. Your role
   □ Student
   □ Scholarship Org.
□ Employer □ Other

3. Your age

□ 18–25 □ 56–65
□ 26–35 □ 66–75
□ 36–45 □ 76–85

4. What is your major

□ Information Technology □ Business Administration
□ Economics and Finance □ Education
□ Politics □ Public Health
□ Medicine □ Other, please specify ______________

5. How many years have you worked for your current organization?

□ less than 1 year □ 11 - 15 years
□ 1 – 5 years □ more than 15 years
□ 6 – 10 years

6. How many years have you worked in your current position in the organization?

□ less than 1 year □ 10 - 15 years
□ 1 – 5 years □ more than 15 years
□ 5 – 10 years

7. Your job title is ________________________________

Thank you for participation in this study.
Appendix B. Interview Questions of Information Exchange among Multi-Stakeholders for Improving Decision Making

The interview is a semi-structured interview which will take proximality 20-30 minutes to be completed. The protocol of the interview will be as follows:

1. **Introduction:**

   I am Ali Bazarah a PhD student in Information System and Technology at Claremont Graduate University. First of all, I would like to thank you for agreeing to participating in my research. The purpose of this research is to evaluate a web-based decision support system for Information Exchange between different stakeholders. The research is intent to propose an artifact, Dashboard, to improve the decision making for stakeholders. The Dashboard is a web-based application that seeks enable stakeholders (e.g., Students, scholarship organizations, and employers) to access comprehensive information that is shared by different stakeholders in an interactive way and use it to support their decisions.

2. **What is the current process of making decisions, do you consider relevant outside information during the process of making a decision?**

3. **Showing the web-based system and asking the interviewee to explore it.**

4. **After interviewee complete exploring the system, I will ask some of following questions:**

   - What do you think about the system?
   - Would you use the system for decision making?
   - Why / why not do you think that the system will help you make a better decision?
   - What do you think of the data visualization? Coloring? Ease of navigation?
   - What functions did you find mostly useful in the system?
   - which component helps (does virtualization help? Does the common information help? How about information quality and system quality)?
   - Would you participate in IE platform, and why?
• What is the expected outcome you anticipate from participating in IE?
• What benefits you would get by using this platform?
• What features/functions should be added to help the decision-making process?
• How easy could you find a piece of information you want to know about a certain thing?
• How did you find the system response time during the navigation process?
• Emerging questions if needed

5. Closing the interview and thanking the interviewee for his/her participation.
# Appendix C. Descriptive Results of User Satisfaction across the Roles

Your Role * Mean computed US Crosstabulation (N = 30)

<table>
<thead>
<tr>
<th>Role</th>
<th>US Mean</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.00</td>
<td>4.00</td>
<td>4.25</td>
<td>4.50</td>
<td>4.75</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Count</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>% within Role</td>
<td>9.1%</td>
<td>27.3%</td>
<td>13.6%</td>
<td>13.6%</td>
<td>4.5%</td>
<td>31.8%</td>
</tr>
<tr>
<td></td>
<td>% within us mean</td>
<td>100.0%</td>
<td>85.7%</td>
<td>60.0%</td>
<td>100.0%</td>
<td>25.0%</td>
<td>77.8%</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>6.7%</td>
<td>20.0%</td>
<td>10.0%</td>
<td>10.0%</td>
<td>3.3%</td>
<td>23.3%</td>
</tr>
<tr>
<td>Scholarship</td>
<td>Count</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Organization</td>
<td>% within Role</td>
<td>0.0%</td>
<td>20.0%</td>
<td>20.0%</td>
<td>0.0%</td>
<td>40.0%</td>
<td>20.0%</td>
</tr>
<tr>
<td></td>
<td>% within us mean</td>
<td>0.0%</td>
<td>14.3%</td>
<td>20.0%</td>
<td>0.0%</td>
<td>50.0%</td>
<td>11.1%</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>0.0%</td>
<td>3.3%</td>
<td>3.3%</td>
<td>0.0%</td>
<td>6.7%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Employer</td>
<td>Count</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% within Role</td>
<td>0.0%</td>
<td>0.0%</td>
<td>33.3%</td>
<td>0.0%</td>
<td>33.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td></td>
<td>% within us mean</td>
<td>0.0%</td>
<td>0.0%</td>
<td>20.0%</td>
<td>0.0%</td>
<td>25.0%</td>
<td>11.1%</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.3%</td>
<td>0.0%</td>
<td>3.3%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>% within Role</td>
<td>6.7%</td>
<td>23.3%</td>
<td>16.7%</td>
<td>10.0%</td>
<td>13.3%</td>
<td>30.0%</td>
</tr>
<tr>
<td></td>
<td>% within us mean</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>6.7%</td>
<td>23.3%</td>
<td>16.7%</td>
<td>10.0%</td>
<td>13.3%</td>
<td>30.0%</td>
</tr>
</tbody>
</table>
## Appendix D. Descriptive Results of Perceived Usefulness across the Roles

<table>
<thead>
<tr>
<th>Your Role * Mean computed PU Crosstabulation (N = 30)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean computed PU</td>
<td>Count</td>
</tr>
<tr>
<td>Your Role</td>
<td>Count</td>
</tr>
<tr>
<td>% within Your Role</td>
<td></td>
</tr>
<tr>
<td>% within Mean computed PU</td>
<td></td>
</tr>
<tr>
<td>% of Total</td>
<td></td>
</tr>
<tr>
<td>Scholarship Organization</td>
<td>Count</td>
</tr>
<tr>
<td>% within Your Role</td>
<td></td>
</tr>
<tr>
<td>% within Mean computed PU</td>
<td></td>
</tr>
<tr>
<td>% of Total</td>
<td></td>
</tr>
<tr>
<td>Employer</td>
<td>Count</td>
</tr>
<tr>
<td>% within Your Role</td>
<td></td>
</tr>
<tr>
<td>% within Mean computed PU</td>
<td></td>
</tr>
<tr>
<td>% of Total</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
</tr>
<tr>
<td>% within Your Role</td>
<td></td>
</tr>
<tr>
<td>% within Mean computed PU</td>
<td></td>
</tr>
<tr>
<td>% of Total</td>
<td></td>
</tr>
</tbody>
</table>

117
## Appendix E. System Usability Scale (SUS) Results

**SUS (N = 30)**

<table>
<thead>
<tr>
<th>SUS1</th>
<th>SUS2</th>
<th>SUS3</th>
<th>SUS4</th>
<th>SUS5</th>
<th>SUS6</th>
<th>SUS7</th>
<th>SUS8</th>
<th>SUS9</th>
<th>SUS 10</th>
<th>SUS_Score</th>
<th>SUS_Row_Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>32</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>26</td>
<td>65</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>27</td>
<td>67.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>39</td>
<td>97.5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>31</td>
<td>77.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>33</td>
<td>82.5</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>21</td>
<td>52.5</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>33</td>
<td>82.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>33</td>
<td>82.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>25</td>
<td>62.5</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>38</td>
<td>95</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>26</td>
<td>65</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>32</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>31</td>
<td>77.5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>38</td>
<td>95</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>38</td>
<td>95</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>19</td>
<td>47.5</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>33</td>
<td>82.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>38</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>39</td>
<td>97.5</td>
</tr>
</tbody>
</table>

**SUS Final Score** 81.33
Appendix F. Map Pop Up Configuration

To configure the pop up of the total number of students in each country, I first added the world country layer, then within this layer I wrote a code “Arcade expression” that brings the data from the student feature layer. Here is the code:

```javascript
var stu = FeatureSetByName($map,"Stakeholder_Students")
var countstu = count(intersects(stu,$feature))
return Round(countstu,0)
```

I also create symbols for each stakeholder so they can be easily identified by looking at the map, and I set up the interval refresh of this map to every minute.