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Title of Thesis: An Effective Approach To Requirements Engineering For Information Systems Consulting

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ABSTRACT

Title of Document:	AN EFFECTIVE APPROACH TO REQUIREMENTS ENGINEERING FOR INFORMATION SYSTEMS CONSULTING.
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Information system (IS) consulting methodologies have evolved to reduce the failure of IS projects. Most studies attribute the failure of IS projects to incorrectly gathered requirements by IS consultants for different reasons, including the lack of effective requirements engineering (RE) methodologies, communication challenges between consultants and their clients, and a consultant's experience in the field. This thesis proposes an Effective Requirements Engineering Methodology (EREM) conceptual system to solve those issues. Indeed, EREM incorporates the various key RE components into one mobile collaborative system, which simplifies communication between consultants and their clients. The elicitation, analysis, documentation, validation, and management steps are performed simultaneously, by displaying self-explanatory form-like guides, scoring instruments, and visual representations. Also, the proposed approach's success is independent of a consultant's experience in the field. A case study at a medium sized nonprofit organization was conducted to demonstrate EREM's practical implications.

AN EFFECTIVE APPROACH TO REQUIREMENTS ENGINEERING FOR INFORMATION SYSTEMS CONSULTING

By

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Chapter 1: Introduction

Over the years, the subject of information systems (IS), or computer systems analysis, has evolved with the increasing use of computers [48]. As such, various definitions of IS were developed to determine what IS constitutes. Indeed, some define it by its components, while others highlight its role in an organization [46, 49]. By combining both perspectives, IS can be defined as a collection of related items, which include hardware, software, and telecommunications networks, that aims to achieve a goal by collecting, storing, manipulating, and transforming data into information for an organization [46, 49]. Data collected from different organizational activities help an organization make important business decisions by analyzing information, with fewer human-related errors, and in a timely manner [4]. Data that is transformed into information can also be valuable to new entrepreneurs, such as when setting up their businesses and conducting market analysis [4]. Hence, the effective management of an IS is crucial to an organization's success. Organizations can hire information systems consultants to help achieve optimal use of their IS. According to Djavanshir and Tarokh [1], the term *consulting* does not have a specific definition, but they state that providing consulting services generally entails providing expert advice in a domain-specific field to clients [1].

Most information system consulting services revolve around outsourcing repetitive and similar IS services, analyzing unique IS organizational opportunities, and developing custom applications [44]. Organizations outsource IS for many reasons, including to reduce overall costs, compensate for the lack of specialized skills, focus on other more important aspects of a business, and gain access to the latest technology [10]. Outsourcing IS services could fall into the following five categories: meeting short-term demands by contracting IT personnel; outsourcing an entire IS project; outsourcing significant IS activities; outsourcing, deploying, and managing applications; and outsourcing selective IT services [44]. In contrast, the analysis of the specific needs of an organization helps optimize an organization's IS performance and assures the integration of their IS [44]. Sometimes, clients invest in IS consulting services to remain competitive in their industry. By contracting IS related activities, organizations will not have to worry about keeping up with the ever-changing technological advances [44]. Over the years, companies have increasingly relied on purchasing custom applications instead of developing them in-house. That way, they can save on overhead costs. Regardless, every type of IS consulting project's success relies on a consultant's understanding of the needs and requirements of the client [1, 20, 67, 68, 69]. As such, the IS requirements of a client, which are statements that reflect and specify important needs and wishes of an organization, can be considered as the basis of any IS project [20, 58].

To identify requirements of an organization, various frameworks have been created that encompass elements of requirements engineering (RE). RE provides high-level guidelines to help gather, manage, document, validate, and analyze requirements [20]. Although RE highlights the necessary components to gather requirements, there is not an agreed-upon procedure or standard that details the process to effectively identify correct requirements. Multiple information system consulting models have been created to help manage RE IS projects. However, those models are not comprehensive. They are limited to defined projects (such as risk-centered IS projects) and organization types (such as the size of a company), among others. This has led consultants to adopt different approaches to identifying requirements [11, 25].

The lack of effective methodologies can, in turn, confuse new consultants on what to do on their assigned IS projects, which would impede the success of an IS project. Indeed, most researches attribute the failure of IS consulting projects to incorrectly gathered requirements by inexperienced IS consultants [8, 28, 30, 56]. This mostly applies to software development related IS consulting projects. According to a study conducted by Beichter et al. [28], 70% of system related errors are caused by inadequate system requirements while only 30% of errors were due to design problems. The failure of IS projects is also attributed to the misunderstanding and poor communication skills between consultants and their clients [24, 31]. In addition, a consultant's experience in gathering requirements plays a significant role in the success of an IS project [1, 9]. This is mainly because gathering and prioritizing,

unambiguous, effective requirements that address different stakeholders' and systems' needs, using an IS model that aligns with an organization's project process methodology, is a complicated task that can become easier over time [67]. This signifies that a new consultant will initially have a lower likelihood of succeeding in an IS project. Hence, current RE and IS consulting practices have the following limitations:

1. Lack of effective RE methodologies that can be applied to any organization type and IS consulting project.
2. Ineffective methods to resolve communication challenges between consultants and clients.
3. Non-existing effective tools for new consultants to use and successfully provide IS consulting services.

To further address the limitations of existing RE practices and analyze how to optimize the benefits of RE for IS consulting projects, the following research questions have been formulated:

RQ1: How can a detailed methodology effectively measure an IS performance at the functional level of any organization type?

RQ2: What are the key effective RE determinants that simplify a consultant's understanding of an organization's needs and simplify communication with a client?

RQ3: How can a consultant successfully optimize the effectiveness of RE, regardless of his or her experience in IS consulting?

By answering those questions, the contributions of this thesis are multifold. It addresses problems and limitations of existing requirements engineering practices. It also proposes an approach to an effective requirement engineering methodology (EREM) conceptual system that addresses and solves those issues.

There are multiple benefits to conducting this thesis. First, effectively gathering the right requirements are of utmost importance for the success of any IS project. Indeed, the gathered requirements dictate the course of an IS project, particularly when developing custom applications. This is mainly because requirements help determine exactly what a system is supposed to do, as well as how it should accomplish it [69]. Requirements also address different system users' goals, needs, and wishes to minimize conflict. Furthermore, they help identify the roles and needs of a client's stakeholders, their organization's processes and purposes, and their technological systems [67]. Requirements are particularly crucial to determining a client's systems' needs since the effective use of software products can optimize the overall performance of an organization and as well as give them a competitive advantage [68]. Furthermore, having a consistent and complete list of requirements is important as it helps avoid unnecessary costs and saves time spent on a project [30].

The proposed methodology is designed to enable consultants, regardless of their level of expertise in the field, to measure an information system's effectiveness as well as identify and prioritize effective requirements. It also helps increase their

understanding of their client's organization and simplify communication with their clients. The EREM approach's practical application is demonstrated via a case study conducted at a medium sized non-profit organization.

The rest of this thesis is organized as follows. The second chapter of this paper discusses the different characteristics of the information system consulting process. The main participants of the IS consulting process are described as well as their roles and responsibilities. The various models of conducting IS projects are elaborated and the determining project success factors discussed. The third chapter of this paper explains the role of requirements engineering and focuses on its components. The components include the methods of eliciting, documenting, managing, validating and analyzing requirements. Different types of requirements are also described. Chapters four and five describe the EREM conceptual system and its application in a case study. The research method used to conduct the case study is also stated. The chapters also provide an in-depth overview of the four-step procedure of the EREM conceptual system and its standard guides. The sixth chapter discusses the results of the research, its research contributions, its practical applications, its limitations, and future research improvements. The conclusion of the research is included in the seventh chapter.

Chapter 2: Information system consulting characteristics

2. 1. Stakeholders

Stakeholders are defined as human beings or organizations that directly or indirectly affect the system requirements of an organization [20]. In IS consulting projects, two types of stakeholders exist: organizational stakeholders and consultants. Organizational stakeholders vary from one organization to another. Nevertheless, they are mostly grouped into two categories: internal and external stakeholders [51]. External stakeholders, also known as secondary stakeholders, are people who would purchase products or services that the company provides, while internal stakeholders, or primary stakeholders, are the employees that work at that organization [33]. The primary stakeholders are further divided into sub-groups such as managing directors, and staff. This is mainly because each stakeholder has a specific role in an organization's information system, and may differently impact an organization's objectives [30]. Analyzing and determining stakeholders can be accomplished by using different methods, including an Organizational Semiotics Analysis [8]. When using the Organizational Semiotics Analysis approach, a consultant would have to primarily identify an organization's problem domain to be able to define the stakeholders and their behaviors in relation to the business-level issue [19].

In contrast, IS consultants are individuals that provide consulting services based on their expert knowledge in IS to their clients [1]. Consultants have a vital role in the success of an IS project. The service quality provided by a consultant directly impacts an IS project. Moreover, there seems to be a significant relationship between a consultant's consulting skills and an IS project's success factors, particularly when dealing with ambiguity and building relationships [9]. Furthermore, Djavanshir and Tarokh [1] suggest three main factors lead to successful consulting: a consultant must be a great listener, understand the client's' needs and requirements and be able to provide honest feedback. According to this article, to become a great listener, a consultant must pay attention to the client's employees of different departments, holding different positions in the company, such as mid-level managers from various departments. This in turn, allows consultants to get more detailed information about an organization's strengths and weaknesses. For example, mid-level managers are more likely to have in-depth knowledge of lower level issues that higher level managers would not. To clearly understand a client's needs and requirements, a consultant should continuously observe and collect information from stakeholders. It is important for consultants to have a clear understanding of an organization's strategy since a consultant's recommendations could impact an organization's long-term strategy. The article also mentions that it is crucial for consultants to analyze the client's history as it could give insights into the factors that led to requiring a consultant's help. Finally, consultants should provide honest feedback to their clients to minimize asymmetric information between them. Indeed, the article mentions that

active involvement in office politics could reduce the chances of providing solutions to the customer. This, in turn, would negatively impact the consultant's career.

2. 2. Information system consulting models

To ensure the success of IS projects, consultants select an IS consulting model that fits the IS service requested by the client. While there are various types of IS consulting models, requirements engineering-centered IS consulting services tend to fall towards Software Development Life Cycle (SDLC) models or Software Quality Assurance (SQA) models [25]. The latter models are generally integrated in every SDLC model [84]. Hence, only the SDLC models will be discussed further. The most common SDLC models, which include the waterfall model, the agile model, the v-model, iterative model, the spiral model, the prototyping model and the rapid application development model, will be introduced in the rest of this subsection [25]. Each model has benefits and limitations based on various features such as the ability to correctly gather user and system requirements of a client.

2. 2. 1. Software Development Life Cycle models

The Waterfall model has six clear, separate phases. Those are Analysis, Design, Development, Testing, Implementation, and Maintenance, respectively. This is the oldest and most popular method that employs a strict sequential progress [53]. The user and system requirements are only gathered before the design phase. This is beneficial as it allows project members to have a clear idea of the requirements before developing the software, which reduces the number of resources needed. However,

this model prevents the project members to make changes to the requirements once that phase is completed and the team members are working on the following phases. As such, some issues that could arise in later phases cannot be easily fixed, reducing this model's flexibility. Each step is also extensively documented and has a specific completion timeframe before moving to the next step [11]. When selecting the right approach, it is necessary for consultants to think of the following four points: the stability of the requirements, the users of the system, the size of the project, and the location of the project team for ease of communication purposes [11].

The V-Model is an extension of the waterfall methodology. Indeed, it has a similar approach but addresses some of the limitations that the waterfall model has. It has a verification step in each phase before moving to the next phase [11, 53]. As such, a developer and a tester can work together to fix issues more easily throughout the development process. Another benefit of implementing this model is that requirement changes can be accommodated in any phase. However, changes to the requirements would require changing documentation throughout the development process, particularly when changes are made in the testing phase. Furthermore, this method is not recommended for short-term projects as multiple testing would require more time [11, 53].

The Agile model differs from the Waterfall and V-Model as it is more flexible and adaptable. Indeed, this model welcomes requirement changes throughout the process.

Also, this model focuses on satisfying the customer. As such, small software pieces are sent out, within weeks, to the customer throughout the process, and changes are made when needed. A lot of time is spent communicating the needs and requirements of the software with the client which helps clarify the requirements for the project. However, there are downsides of implementing this model. Only senior developers are more likely to handle making important decisions for the development process. This method is also more profitable for smaller projects, but not for larger projects. This is because, it is difficult to judge the efforts of a consultant and the required time needed to complete a large project [11]. Other problems with this approach include insufficient user story formats or guides, difficulties in prioritizing requirements, growing technical debt, reliance on tacit requirement knowledge, and imprecise effort estimates [43].

The Iterative model, also known as the incremental model, is like an iterative waterfall model [86]. Indeed, a consultant gathers the basic requirements in the initial stage of the iterative model, to build, test, and implement the software iteratively by slowly adding software functionalities [88]. To accomplish this, the initially gathered requirements are first prioritized and then divided into groups. Each group is then used to build the software iteratively, if all the client's needs and requirements are satisfied [85]. Hence the success of this model heavily relies on the validation of all the gathered requirements and thorough testing of the software throughout the IS project. This model is more appropriate for IS projects that focus on the close

maintenance of a project or software to mitigate risks and that have a tight budget or for clients that would like to see results quickly [86].

The Spiral model is a combination of the Waterfall model and the Iterative model with a focus on risk analysis [85, 88]. This model follows an iterative four-step process that includes a planning phase, a risk analysis phase, a development phase and an evaluation phase. The planning phase identifies system and user requirements through systems analysis and communication with the clients. The risk analysis phase determines potential risks and mitigations of a project's software, and produces a prototype. The development phase involves the actual software development and testing. During the evaluation phase, the client evaluates the output of the project [88]. Once the development phase of the software is complete, the installation and maintenance phases are carried out [87]. The main philosophy behind this approach is to start with a small set of requirements by keeping in mind the big picture of the project's goal, and adding requirements onto the project like a spiral [85, 86]. This method is very beneficial for high-risk IS projects with a lot of financial resources [86]. However, this model requires clients to have very flexible IS projects as many iterations will be made throughout the project. It also heavily relies on the consultant's understanding of the needs of the client as well as the consultant's skills in identifying the right risk-related system requirements [86].

The Prototyping model is simply focused on building a prototype that satisfies user requirements. It tends to be implemented as an additional method to using another SDLC model, such as the Spiral and Iterative models [89, 90]. Unlike the previously mentioned models, the consultant is not required to elicit requirements [89]. Instead, the consultant would begin the IS project by using the client's requirements and building a small prototype. Then, the prototype is iteratively evaluated and modified to address all the client's new requirements. This process can be quite time consuming, costly, and complex if communication between the consultant and the client is difficult. However, the model may help highlight the prototype risks and feedback can be received quickly [89, 90].

The Rapid Application Development (RAD) model is a combination of the Prototyping model and the Iterative model with an emphasis on delivering results quickly [86, 90]. In this model, the consultant and the client would work collaboratively to elicit, test and validate prototypes' requirements iteratively. This model would be applicable only if the requirements are well understood and the IS project goals are limited and time-sensitive [87]. The process can be quite costly and limited documentation or training is provided [90]. One of the top advantages of this model is its flexibility to handle changes quickly [90].

2. 2. 2. Software Development Life Cycle models' limitations and trends

The Software Development Life Cycle (SDLC) models' descriptions and limitations are summarized in Table 1. Most of the models are variations of, or inspired by, the

waterfall model. Almost all the SDLC models' limitations include their success dependency on a consultant's expertise in the field, communication skills and ability to clearly understand and elicit the right requirements. In addition, the cost, and time consumption of the SDLC models are recurring limitations. Furthermore, the models are not applicable to all types of projects. The prioritization of requirements is also another limitation that affects multiple models.

Model name	Description	Limitations
Waterfall Model	Uses a strict 6 step sequential process that includes: Analysis, Design, Development, Testing, Implementation, and Maintenance, respectively.	● requirements are only elicited before the design phase ● success heavily relies on a consultant's expertise and understanding of the requirements ● not flexible in adjusting requirements ● not suitable for complex or large IS projects ● not suitable for ongoing IS projects ● not suitable for high risk IS projects
V-Shaped Model	Waterfall model with validation phases and adjustable requirements	● unclear process for testing phase ● least flexible in adjusting requirements ● process can be costly ● not suitable for complex or large IS projects ● not suitable for ongoing IS projects
Agile Model	Flexible waterfall and v-shaped model	● success heavily relies on a consultant's expertise and understanding of the requirements ● success heavily relies on eliciting and prioritizing the right requirements ● success heavily relies on consultant's communication skills ● minimum documentation ● imprecise effort estimates ● not suitable for complex or large IS projects ● process can be costly
Iterative/Incremental Model	Iterative waterfall model	● success heavily relies on a consultant's expertise and understanding of the requirements ● success heavily relies on eliciting and prioritizing the right requirements

		● process can be very time consuming
Spiral Model	Iterative waterfall model with an emphasis on risk analysis	● success heavily relies on consultant's communication skills ● success heavily relies on consultant's understanding of the requirements ● only suitable for risky IS project ● process can be costly ● iteration may be time consuming
Prototype Model	Building iterative prototypes based on client's requirements	● Difficult to test for prototypes that have many requirements ● time consuming ● process is very costly ● misunderstanding of requirements can really affect the IS project
Rapid Application Development (RAD) Model	Iterative prototype based model that provides quick results	● misunderstanding of requirements can really affect the IS project ● success heavily relies on a consultant's expertise and understanding of the requirements ● process can be very costly

Table 1: Software Development Life Cycle descriptions and limitations

Regardless of all the listed limitations, the most common SDLC approaches to date are the agile model and the traditional approach [52]. The traditional approach follows a series of consecutive phases. Some of the common traditional approach methodologies include the waterfall model and the v-model. On the other hand, the agile approach follows an iterative process. The use and implementation of agile development methodologies have more than doubled since 2003 compared to traditional methodologies [25]. The prototyping model is also becoming more prevalent these days [25]. On the other hand, the Spiral and Incremental model have steadily decreased over the years. Even though the incremental model was the second most popular SDLC model in 2003, it has more than cut its popularity in half in 2013. These SDLC model trends and changes over time indicate that consultants are still

experimenting with different models because the existing models have various limitations and there isn't one that fits all their needs.

2. 3. Information system project success factors

To successfully measure an IS project's success, it is important that a consultant aligns an organization's IS goals with its organizational goals [8]. However, there are various reasons why accomplishing that can be quite challenging, including inflexible alignment strategies, and poor knowledge management by an organization, amongst others. Nevertheless, the values added to an organization's goals by their IS (at full capacity and with minimal cost), measure the quality of an organization's "IS-Organizational" alignment quality [12]. To optimize an organization's IS-Organizational alignment, it is important that consultants gather requirements correctly [8]. As mentioned in a research, there is a 30% chance that a business-IS alignment strategy could fail [8]. Therefore, paying attention to all types of business requirements is crucial. As such, improving the requirements engineering process is very useful.

Many IS studies confirm that the Delone and McLean Model of Information System Success Model is mostly effective [17, 18]. The model, as shown in Figure 1, has been reviewed and updated numerous times to address its limitation [18]. The latest updated model has three main quality dimensions: information quality, system quality, and service quality. According to the model, those dimensions will affect a system's usage and the users' satisfaction. In turn, those will generate to different net

benefits [18]. Hence, the components of that model contain important characteristics for the success of an IS project. As such, when gathering requirements, a consultant should address the elements of that model.

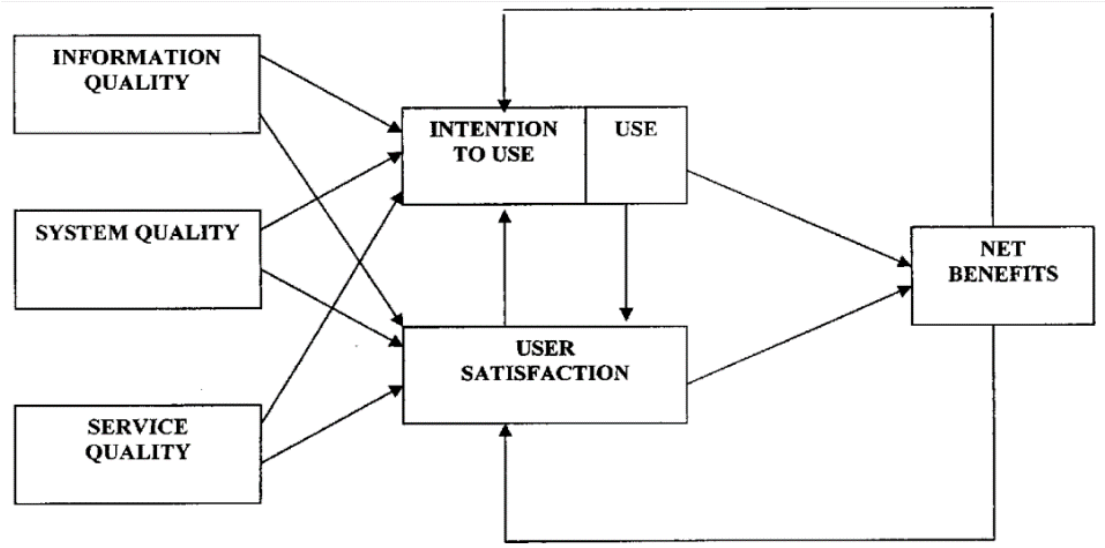

Figure 1: Delone and McLean's Updated IS Success Model (Adopted from [18])

The system quality dimension includes the usability, availability, reliability, adaptability and response time of a system [18]. On the other hand, the information quality aspect captures the content of software by ensuring that the system provides relevant, complete, simple customizable, and secure information [18]. In contrast, the service quality dimension focuses on the overall support provided by the system. The usage category includes all the activities performed using the system, while the user satisfaction category measures the opinion of the users. Finally, the net benefits element demonstrates the advantages and the drawbacks of a system [18].

Chapter 3: Requirements Engineering

3. 1. Requirements engineering-related definitions and roles in information system

Requirements are statements that describe what a client needs from an information system [58]. Requirements can be classified into two categories: system requirements and user requirements [59]. The system requirements identify what a system is expected to do and how it will accomplish that goal. System requirements sub-categories include functional and nonfunctional requirements. Functional requirements state what a system is expected to do without considering its physical constraints. On the other hand, non-functional requirements explain how a system will satisfy requirements by considering its various constraints [55]. In contrast, user requirements determine a system's users' needs and how the requirements will impact its users [59].

Requirements engineering is a structured method that uses requirements to reflect and specify pertinent organizational needs and wishes [20]. Different literary works provide explanations for IS project failures or successes that are due to requirements engineering [25, 30, 58]. For example, the Guide to the Software Engineering Body of Knowledge (SWEBOK v3.0), describes that software project success heavily relies on the quality of a requirements engineering (RE) process [25]. In addition, a study conducted by the IAG Consulting group found that the most commonly mentioned

reason for project failure is due to poor requirements gathering methods [25]. Furthermore, another research states that having a consistent and complete list of requirements is important, as it helps avoid unnecessary costs and saves time spent on a project [30]. However, selecting the right requirements elicitation method can be a difficult task. The different needs and objectives of an organization and its stakeholders largely contribute to those difficulties. Indeed, a Standish study states that out of 1027 projects, only 12.7% were successful [30]. According to that study, the lack of clear objectives and requirements led to the projects' failure.

3. 2. Requirements engineering process

Requirements engineering is an iterative process that has been traditionally used at the beginning of an information system consulting process [55]. There are five main activities during the RE process: eliciting, analyzing, documenting, validating, and managing requirements [56, 57]. Those phases generally begin with the elicitation process, but they are then used differently depending on a consultant's information system model.

3. 2. 1. Requirements elicitation

The requirements elicitation phase of the requirements engineering process aims at identifying and gathering an organization's goals, needs, and requirements from different perspectives [57, 55]. This is an important step as any change to the collected requirements would affect the final product or service [36]. As such, it is important to implement elicitation techniques that would help gather the correct

requirements to achieve the organization's objectives. Regardless, there are three primary sources of eliciting requirements: stakeholders, documents, and systems in operation. Indeed, stakeholders can explicitly or implicitly impact requirements, documents can provide relevant information about the requirements, and the systems in operation can help stakeholders identify their needs by testing old, current, and competing systems [20]. From those sources, a consultant would be able to focus on eliciting requirements about all the stakeholders (identifying the main participants and their roles in the IS of the organization) and the goals of the IS project (high-level and low-level objectives that align with the business objectives of the client) [56].

To select the right requirement elicitation method, it is important to consider the following factors: the differences between the conscious, subconscious, and unconscious requirements; considering constraints such as time, financial and stakeholders' availability; the requirement elicitation experience of a consultant; and the opportunities and risks associated with completing the project. It is also advised that a consultant begins by doing an analysis of the constraints related to the project and maintains good communication with stakeholders and understand their expectations. The consultant should also keep in mind organizational and operational influences [20].

As mentioned above, there are multiple requirement elicitation methods. However, selecting the right elicitation technique depends on the consultant's time, resources,

and type of information that will be collected [56]. Even though there are multiple ways of eliciting requirements, the number of elicitation techniques used per IS consulting project has been reduced from 3-4 techniques in 2003 to 2-3 in 2013 [25]. In addition, in 2003, use cases and scenarios were prominent, while, in 2008, interviews were the dominant elicitation methods, followed by scenarios. Prototyping methods surged in 2013, even though interviews are still considered the main elicitation methods of that period [25]. There are five main types of requirement elicitation methods: survey, creativity, observation, support-based, and feedback techniques:

- The survey method includes interviews and questionnaires. Interviews are conducted with one or two stakeholders with a predetermined set of questions, which can be time-consuming. Moreover, questionnaires are more appropriate for a larger number of stakeholders, can limit the requirements gathering to the questionnaire's designer [20, 56].
- The creativity approach includes brainstorming, by involving 5-10 people and documenting their ideas. Some of the methods in the creativity approach include using brainstorming-paradox, which includes the collection of events that are not supposed to happen, and using the change of perspective method, of which the Six Thinking Hats technique is the most common one (where six stakeholders adopt six different points of view when discussing the requirements) [20]. Another creativity approach includes the analogy method where each problem is associated with an analogous situation to help them

visualize them better. For example, metaphors and personas could be used to help the stakeholders better understand the requirements [57]

- Field and apprenticing observation methods help clients who are unable to define their requirements, and help consultants observe how an organization functions and ask questions [20]. This method also enables consultants to better understand the context and environment of a client's IS [57]
- Support techniques offer additional requirement elicitation methods through, for example, mind-mapping (graphical representation of processes or events) or workshops (where stakeholders and consultants discuss the objectives) [20].
- Feedback techniques aim at gathering requirements by providing documents and visual displays for stakeholders to review and give feedback to a consultant [57]. The most common method is prototyping [56]. Other types of methods include use models, model animations, simulations, and storyboards [57].

3. 2. 2. Requirements analysis

The objective of the requirements analysis phase is to examine the elicited requirements using various methods. During this phase of the RE process, the elicited requirements are first categorized and analyzed separately. This allows the consultants to see if there are any contradicting requirements and have a better understanding of the overall environmental context of the requirements [56]. Afterward, different types of analysis can be conducted. For example, a consultant

could create, organize, and prioritize the requirements [56]. In addition, it is also important for a consultant to understand the different connections between the information system goals of each organization in understanding their requirements. Studying the causality of those goals helps determine the user's needs and requirements [32]. Similarly, consultants can also run a risk or impact analysis, which would assist them identify the relationships between the requirements and their possible consequences [58].

Various methods exist for discussing, agreeing, and selecting a requirements prioritization method. Some of those techniques include business case analysis/return on investment (ROI) estimation, pairwise comparison, and quality function deployment (QFD). The analytic hierarchy process, or AHP, was created by Thomas Saaty and applied by Joachim Karisson and Kevin Ryan in software engineering. The AHP is a technique that helps make decisions when various objectives are involved by using a pairwise comparison method, which includes five steps. First, the requirements are reviewed for completeness. Then, the pairwise comparison is applied to evaluate the relative value of those requirements and the costs related to their implementation. Afterwards, each requirement's relative value and implementation cost is calculated and plotted on a cost-value diagram. Finally, the requirements are analyzed from the cost-value diagram [28].

In a goal-oriented requirement engineering (GORE) approach, the requirements goals are represented on a graph called the goal graph. A (parent) goal is refined into sub-goals. The sub-goals enable the parent goal to achieve its objective. As such, the parent goals' success depends on its sub-goals. According to the authors, this method of refining goals is implemented in most of the GORE approaches. In some instances, consultants consider refining the main aims into tasks and activities, while others refine those goals into conditions and limitations. In the first case, a consultant would be implementing an operational point of view of the GORE approach. On the other hand, in the latter case, a consultant would see the GORE approach in a logical perspective of the conditions [32].

3. 2. 3. Requirements documentation

The documentation stage of the requirements engineering phase aims at capturing and correctly displaying the requirements [56]. Both stakeholders and consultants benefit from drawing or sketching requirements. Indeed, the documentation of requirements helps foster creativity and simplifies communication and understanding between the stakeholders and consultants [23]. One of the most common methods of documenting requirements is with the use of the Unified Modeling Language or UML [60]. The UML is a standard of terms and diagrams conventions that provide a way to help stakeholders and consultants visualize a system and its requirements [60]. Most of the other types of documenting methods also focus on the language specification of the requirements [57]. The terms used in those documentations can range from informal to very formal languages.

The semiotic approach tries to find meanings of a business-level issue and display it in a graphical form [19]. To apply this method, a consultant would first define the problem domain and then provide a list of vocabularies to define the actors and their behaviors. During the problem domain phase, all relevant documents are reviewed, to identify the main problems, and are summarized in a written document. Then, in the candidate affordance generation phase, the collected documents are studied, and semantic units are determined. Those units, such as action verbs, nouns, and prepositions, are generally identified then categorized in tables by keeping the elicitation of important business processes in mind. Afterward, the candidate grouping involves organizing those semantic candidates as agents or affordances [19].

On the other hand, the dynamic essential modeling of organizations transaction concept has two important differences from other similar approaches: it distinguishes the differences between business processes and their realization by abstracting from all organizational-related information and human aspects; the model also considers every business model a specific structure having the same generic form. Hence, the DEMO tool is implemented by identifying business processes as transactions and the actors and their responsibilities as initiators or executors of some of those transactions. The Business Oriented Petri Net (BOPN) model is based on the DEMO model that has two transitions that represent intersubjective and objective actions [19].

3. 2. 4. Requirements validation

During the requirements validation step, the requirements are tested to see if there are any mistakes made in the previous stages [43]. It is also the step where the requirements are checked for their consistency and completeness [61]. For an information system consulting project to be successful, it is critical for the stakeholders and the consultants to clearly communicate their ideas and thoughts throughout the RE process and especially in the validation phase. Indeed, the stakeholders should be able to confirm and clarify the requirements so that the consultants can understand and work on them [27]. For those reasons, multiple methodologies exist to simplify communication. For example, an inspection is an approach that is commonly used for validation purposes. It is a process used for consultants to identify conflicting and incomplete requirements [61]. However, using that system can be complicated and time-consuming as it would require users to study a requirement at a time, particularly in embedded systems [39]. Requirements testing, such as misuse cases testing can also be used during the requirements validation process. While use cases are methods of describing the interaction between the users and a system, misuse cases are like use cases that the client does not want to happen. They are useful for ensuring the security and quality of requirements [62, 28]. Other requirements validation methods include reviews, usability validations, and viewpoint-oriented requirements validation and use cases [61, 42].

The most common validation method is prototypes [39]. Prototypes are initial versions of a potential system [62]. Prototypes can be further divided into subgroups: throw-away prototypes and evolutionary prototypes [61]. Throw-away prototypes enable consultants to recognize unclear and inconsistent requirements. After stakeholders and a consultant identify those requirements, they discard the prototype and create a new system. In contrast, the evolutionary prototype is one that constantly changes and builds upon requirements as they come. Indeed, an initial prototype is created and further developed as the requirements are refined throughout the information systems project [61]. Prototyping is quite useful as it helps both consultant and stakeholders get a better understanding of the requirements. This is mainly because the stakeholders can better visualize the expected system and communicate their thoughts with a consultant. However, these methods are time-consuming and quite expensive. It is also difficult to assess the completeness and clarity of the stakeholders' requirements using these methods [39].

Measuring usability can be accomplished by the process of gathering a list of requirements early in the proceedings. It is common practice to start by evaluating and using the natural language of the requirements as a metric to measure the usability of the requirements. This permits the creation of a scorecard against which the quality of the system can be evaluated. The Multi-Attribute Utility Theory (MAUT) is one example of a way of measuring the usability of the requirements. Similarly, the decision tree model is a metric that helps to identify the requirements as

either "accept" or "rewrite." The validation processes that the usability requirements affect include text quality, complexity, completeness, and capacity [42].

3. 2. 5. Requirements management

Once the requirements are collected, it is important for consultants to be able to manage the gathered requirements. As such, the requirements are captured, stored, and distributed during the management phase. The various versions of the requirements are also traced to give the consultants a better understanding of the relationship between the requirements and the result of a system [62]. Consultants must also perform additional analyses during this phase to re-evaluate and better manage the requirements. Some of those include requirements risk analysis and evaluating systems in their operational context [57].

Companies' software intensive systems (SIS) sometimes have over 10,000 requirements, which could be quite difficult to manage. This large number is often associated with the increasing complexity of a system to successfully compete with competitors. In addition, requirements that were initially identified may change over the duration of the software development life cycle. Hence, managing the changes could be a quite complex task, particularly as it could affect multiple internal and external stakeholders. As such, larger organizations could benefit from implementing a design for excellence or DfX process. For the approach to succeed, close cooperation between the stakeholders of the different disciplines is important. In addition, the requirements gathered during the DfX RE process are mostly

constraints. Afterward, the requirements are globally reviewed and validated by performing a feasibility study. Finally, the rest of the unused requirements are stored in a database [33].

3. 3. Challenges and limitations in requirements engineering methodology in information system consulting

3. 3. 1. Lack of effective methodologies

Over the years, consultants have implemented a variety of requirements engineering methodologies when providing their services to their clients [11, 25]. For example, the use and implementation of agile development methodologies have more than doubled since 2003 compared to traditional SDLC methodologies [25]. In addition, in 2003, use cases and scenarios were prominent, while in 2008 interviews were the dominant elicitation methods, followed by scenarios, and prototyping methods, which surged in 2013, even though interviews are still considered the main elicitation methods of that period. Furthermore, requirements analysis and presentation methods have also changed over the years. In 2003, only a few used object-oriented analyses even though they are mostly used in conjunction with use cases and scenarios. In comparison, in 2013, more participants seem to be using them, and more informal language seems to be used when expressing requirements. Moreover, formal walkthroughs seem to be more common in 2003 and 2008, while ad hoc walkthroughs were more popular in 2013. What's more, in 2003, most prototyping methods were evolutionary. That number increased in 2008, but, in 2013, there seems to be more focus on using the user interface instead.

Regarding software quality, it appears that more people agreed that the finished product was satisfactory to the client compared to the earlier years. Nevertheless, in 2008, projects didn't run over the budget as much as in 2008 or especially in 2013 [25]. These changes show that no commonly agreed-upon methodology has been determined as an effective solution. Consequently, the consultants are unable to gather correct requirements, which in turn lead to information systems project failures. Indeed, according to research, 56% of software project failures were related to missed, incomplete, or unclear requirements [61].

3. 3. 2. Communication challenges

The most common problems in RE mentioned in literature works are miscommunications and misunderstandings of the requirements. For consultants and stakeholders to efficiently and effectively discuss the requirements, several methods have been presented. Some authors believe it is important to have a collaborative approach to gather requirements. Collaboration is currently mostly being accomplished ad hoc without a specific framework in mind. Consequently, important information may be missing from collaboration tools during a software development cycle, which in turn would affect the final solution [31]. Others believe that communication challenge with the stakeholders to be caused mostly by language barriers and missing direct communication with a client [24]. This applies when communication difficulties arise when eliciting non-functional requirements and when stakeholders have different views of the final version of the software [42].

The solutions that various authors presented for that issue are to involve an experienced consultant to conduct frequent meetings, introduce feedback loop with their client, and spend more time and energy in requirements elicitation, analysis, and specification. They also suggested that consultants should provide the necessary training to their client and use prototyping [24]. Even though these suggestions could help mitigate some of those issues, without a clear guideline on how to conduct the RE process, the project can run over budget and be time-consuming.

3. 3. 3. Difficulties for new consultants

Interviewing stakeholders alone does not automatically enable a consultant to understand where a problem lies or how to make a system more efficient. This is mainly because, most of the time, a system's users are not even able to know exactly what their needs and requirements are [19]. As such, an experienced consultant's knowledge is an asset. Their knowledge can be categorized as explicit knowledge (documented and codified knowledge that is easily shared with technology) and tacit knowledge (stems from experience and intuition that can be shared through communication) [6]. Hence, experienced consultants play a vital role in the success of an information system consulting project.

Although literature works highlight the importance of having experienced consultants work on those projects, they do not provide a guideline for new consultants to follow suit or how to tap into that knowledge. Some suggest that certain personality types are more suited to becoming successful consultants. For example, the following

personality traits were identified as factors that link to successful projects: the ability to understand, remember and apply; organize thoughts and ideas; decide; and communicate effectively [26, 1]. Therefore, new consultants face difficulties in conducting successful IS projects.

Chapter 4: The proposed approach to an Effective Requirements Engineering Methodology (EREM)

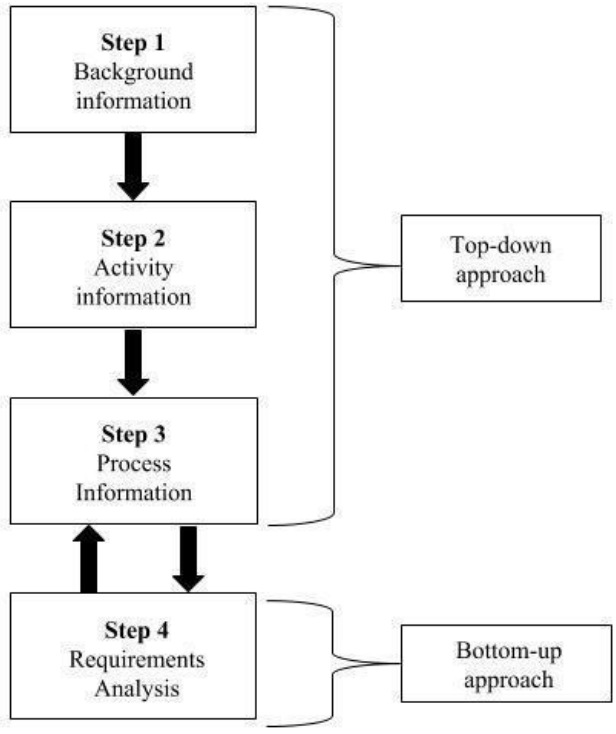

Figure 2: Effective Requirements Engineering Methodology Procedure

4. 1. EREM Overview

The aim of the proposed Effective Requirements Engineering Methodology (EREM) is to effectively identify key requirements for the optimal information system (IS) performance of an organization. EREM accomplishes that by incorporating the various components of requirements engineering into one mobile collaborative

system that uses a four-step procedure, as shown in Figure 2. Below are some of the key characteristics of EREM that address the limitations of existing work, including their lack of detailed and effective IS methodologies, their disregard of the difficulties new consultants face to offer adequate IS consulting services, and their insufficient methods to simplify communication between consultants and clients. To summarize:

- The proposed EREM conceptual system simultaneously helps elicit, validate, analyze, document and manage requirements
- EREM follows a detailed four step process to gather requirements using guides and scorecards.
- The first three steps use a top-down approach to help break down the details of how an organization functions and what it wishes to accomplish. The last step involves a bottom-up approach that provides an overview of the identified critical requirements and determines an information system's performance problems based on the information collected from the previous steps
- The guides and scorecards enable consultants and their clients to easily and effectively gather information on the organization's structure, requirements, priorities, and goals.
- The guides and scorecards also provide simple guidelines for new consultants to more easily address key information system performance indicators including the effectiveness, efficiency, value and commonality of every client's process' information system.

- EREM also uses clients' information system performance results, priorities, and their project goals to effectively prioritize the requirements of identified critical activities, processes, and technological systems.
- EREM simplifies communication for both consultants and clients as they can collaboratively use the system to fill out the guides and view the results in text format or using visual representations

4. 2. Step 1: Background information guide

The first step of EREM enables a consultant to understand an organization's goals, stakeholders, perceived issues, and core functions. Understanding an organization's background is one of the key determinants of effective RE [67, 68, 69]. Indeed, once a consultant fully understands what a client wishes to accomplish and how the client's organization functions, the consultant will be able to address IS issues more effectively. The first guide contains different components organized in sections, including general client information, stakeholders, office culture, client goals and problem statement, activities and their accountable individuals, and comments and version numbers, which will be discussed in detail later in this subsection.

The first step involves the collection of general information about a client's organization, in a form-like template or guide, to enable consultants to retrieve and review IS consulting project. The top section of the guide contains data such as the name of the client's organization, its acronym, and address. The client ID would ensure that a single entry identifies the client, while the project ID would track the

unique project number associated with the client. The year the organization was founded, and the size of the organization (small for 1-50 employees, medium for 51-250 employees, large for 251+ employees) can provide context to a consultant. The client's organization type, "for profit" or not "for profit," distinguishes the financial goal of an organization. The specialties category states the types of services or products an organization offers to their customers. The project start date is also included to enable consultants to easily differentiate between different projects with the same client, in a chronological order. Finally, the cost spectrum is specified in this section. This feature helps determine how an organization views the costs associated with their technological systems. The client will be required to determine a range of costs that are considered high, medium and low.

4. 2. 1. Stakeholders

The stakeholders involve all individuals related to a client's organization [20]. As mentioned in the literature review section, they can be categorized as external and internal stakeholders [51]. The internal stakeholders are employees of a client while external stakeholders are individuals and organizations that are affected by a client's organization. To identify both types of stakeholders, many studies mention the need for an in-depth analysis of the processes of an organization [54, 75, 76]. A study mentions a method that includes the assessment and prioritization of stakeholders based on their skillset and interest in an IS project [75]. Another research describes a method for identifying stakeholders by creating a baseline for independent

stakeholders within an organization [76]. Then, each independent stakeholder's "sub-stakeholders" are analyzed [76].

The guide's stakeholder identification process was inspired by a combination of methods from the studies mentioned above. To increase the efficacy of the stakeholder's identification process, the list of interview questions (see Appendix A) categorizes and prioritizes an organization's stakeholders into two baselines. The external and internal stakeholders are the two baselines of the stakeholder's identification process. External stakeholders' that positively impact an organization's revenue and those who have decision-making powers are prioritized respectively. This is mainly because the amount of revenue an organization receives directly influences the decision makers, which in turn affect the rest of an organization. The external stakeholders include:

- Customers or donors (since an organization is either for-profit or non-profit)
- Board members or investors (individuals who financially expect to see a return on their investment or who want to see specific results within an organization)
- Suppliers (service and product suppliers), and
- The government (all organizations must comply with governmental regulations).

On the other hand, internal stakeholders are identified by first determining an IT or IS department's staff and their level of management. This enables a consultant to know the authority and decision-making structure of an IT department. Those stakeholders are then categorized as top management staff members (individuals that have the decision-making powers), middle management team members (people who are accountable for the implementation of the decisions of top management individuals) and functional staff members (those who implement the decisions of top-level managers).

In contrast to the stakeholders identified above, project stakeholders involve the stakeholders that will take part in an IS consulting project. Since an IS project revolves around technology, staff members from the IT or IS department are prioritized for their technical skills and understanding. Those stakeholders are called primary project stakeholders. The primary baseline stakeholders include an IT executive director (project top-level management), an IT project manager (project middle level management), and an IT system developer (functional project developer). The project stakeholders should also involve other departmental middle management level or functional level stakeholders who are affected by an IS consulting project. Those stakeholders are considered secondary project stakeholders and are described in detail in the second and third step of EREM. Finally, the tertiary project stakeholders include the project test users. Those stakeholders include individuals who would test and help validate the gathered requirements of an IS

consulting project. The tertiary users are mostly determined during the third step of the EREM process.

4. 2. 2. Office Culture

Analyzing the office culture of an organization for IS consulting purposes is quite important. Indeed, an organization's office culture can highlight its values and hint at how they operate [73]. Depending on the size of an organization or leadership style, multiple types of office cultures can exist between and within departments [72]. The guide provides a set of four possible culture types for a consultant to choose from, as determined by Hartnell, C, et al.'s research [72]. The authors mentioned four types of office cultures inspired by Quinn and Rohrbaugh's 1983's competing values framework (CVF). Those include the clan, adhocracy, hierarchy, and market culture classes. Each culture type provides specific values to an organization based on what and how they accomplish their goals, as shown in Table 2.

Culture Type	Assumptions	Beliefs	Values	Artifacts (behaviors)	Effectiveness Criteria
Clan	Human affiliation	People behave appropriately when they have trust in, loyalty to, and membership in the organization.	Attachment, affiliation, collaboration, trust, and support	Teamwork, participation, employee involvement, and open communication	Employee satisfaction and commitment
Adhocracy	Change	People behave appropriately when they understand the importance and impact of the task.	Growth, stimulation, variety, autonomy, and attention to detail	Risk-taking, creativity, and adaptability	Innovation
Market	Achievement	People behave appropriately when they have clear objectives and are rewarded based on their achievements.	Communication, competition, competence, and achievement	Gathering customer and competitor information, goal-setting, planning, task focus, competitiveness, and aggressiveness	Increased market share, profit, product quality, and productivity
Hierarchy	Stability	People behave appropriately when they have clear roles and procedures are formally defined by rules and regulations.	Communication, routinization, formalization, and consistency	Conformity and predictability	Efficiency, timeliness, and smooth functioning

Table 2 Competing Values Framework (CVF) based on organizational functionalities (Adopted from [72])

According to the study mentioned above, the clan culture highly values group cohesion, trust, and transparency [72]. An adhocracy culture focuses on promoting creativity, self-governance, and thoroughness. Hierarchy-based cultures highlight the importance of structured regularity and uniformity. In a market-oriented office culture, competition, communication, and goal-realization are of high importance.

In IS consulting projects, the type of office culture could impact the technology implemented at an organization. For instance, in a clan office culture, an organization may need multiple licenses to software to foster collaboration. The organization may also need to use software that is user-friendly to minimize staff training costs and help increase a membership-like environment at the workplace. On the other hand, in a hierarchy type of organization, every user would have a specific role. As such, they are more likely to have specific logins to each user, and security features may be important. Table 3 shows software related features needed in terms of their importance, to capitalize on the existing office culture and increase the effectiveness of existing information systems, inspired by [73, 74]:

Features	CVF Types			
	Clan	Adhocracy	Hierarchy	Market
Functionality and quality measures	Simple sharing ability, collaboration-oriented, usability (user experience, user design)	Flexibility, customization, portability, ability to integrate, collaboration oriented	Completeness, ability to integrate, efficiency, reliability, traceability/maintenance	Security levels, reliability, business intelligence tools, real-

				time information
Infrastructure priorities	Speed, scalability	Scalability, backup and recovery	Speed, backup and recovery	Backup and recovery, speed, real-time data
Most recurrent costs	Licenses, hardware	Upgrading costs, maintenance	Staff training, installation and implementation	Maintenance, upgrading costs

Table 3: Competing Values Framework based on an organization's information system

4. 2. 3. Client goals and their problem statements

This section of the guide states the mission, goals, and objectives of an organization. It is important to explicitly describe the mission, goals, and objectives, as they can impact the effectiveness of the organization [77]. Indeed, research has shown that unambiguous mission statements tend to increase the effective strategic management of an organization, double the return on shareholders' equity, and increase organizational performance goals [79]. When describing the mission statement of an organization, a consultant will have to clearly understand why an organization exists [78]. For a nonprofit organization, the mission statement would likely fall into influencing individuals or organizations about an issue (political, social, cultural, environmental issues are examples). On the other hand, a for-profit organization would likely want to sell products or services. The objectives of an organization provide details on the functionality, quality, and expected outcome of their mission statement. Finally, a consultant identifies the client's goals, which are the methods implemented to achieve those objectives, and ultimately, the mission statement [77].

Client goals fall under departmental goals, which are categorized as "continuous" or "time-sensitive goals". Time sensitive goals can be further classified as long-term and short-term goals. Since the guide addresses IS projects, the client goals will be focused on the IT or IS department goals.

On the other hand, the project goals section of the guide enables the consultant and the organization to clearly state the purpose and aim of the project. Since the purpose of RE is to identify the needs and wishes of an organization, a consultant's role would focus on helping an organization determine, analyze and document requirements [20]. Even though an organization's IS needs and wishes can vary, they aim to reduce the costs or increase the efficiency and effectiveness of an IS by outsourcing IS services, building custom applications, and developing IT strategy [44]. Constraints related to an IS project are also included in the guide to prepare for possible difficulties. Furthermore, each project's goal success measurement criterion is also specified. This would enable the consultant and the client to focus on achieving the goals [81]. The project success measurement criteria will be listed down in terms of their importance or priority to the client.

The purpose of the problem statement is to explore the symptoms, possible antecedents, and costs associated with an IS project's issues [82]. It is also an effective method for a consultant to validate his or her understanding of the perceived issues with the client. This, in turn, would enable the consultant to address the correct

problem to solve [82]. The problem statement includes the description of the client's discovery process of the perceived issues, their perceived needs, their previous remedies, and their perceived outcomes. The consultant will have to emphasize on the word perceived. This is to encourage the client to be open-minded at the possibility that their perceived information system’s issues and needs may not be exactly what they initially believed.

4. 2. 4. Activities and their accountable individuals

This section lists an organization's activities in order of their importance, and their accountable individuals. For this thesis, an activity is an organization's function that is affected by the organization's IS. Once the activities are identified, an accountable individual and a consultant determine the importance of each activity in terms of their effect on the client's goals. Each activity's importance can be categorized as high, medium and low, with scores of 100%, 50%, and 0%, respectively. Those scores would later help calculate an activity's requirements urgency score, as mentioned in step 4. Below is a more detailed explanation of what “accountable” individual entails.

The "accountable" feature in the guide is a measure that assigns accountability to a staff member of a client's organization. The aim of this feature is to ensure that specified individuals validate the accuracy and completeness of the collected information. The accountable feature addresses the validation component of RE and is critical for the stakeholders and the consultant to communicate and confirm the gathered information clearly [27]. This feature has three status options: assigned, in-

progress, and signed. The "assigned" option means that a person is assigned with reviewing, editing and signing off information on the guide. It would trigger an email reminder for an accountable individual to complete their assignment within a specified date. The consultant and client would also be alerted by email whenever changes are made to the guide. When changes are made to the guide, the status of the guide will change to "in-progress." The process is complete once both accountable individuals have approved the changes and the status is changed to "signed." Then, the following guide is made available.

4. 2. 5. Comments and version number

The comments section enables a consultant and a client to write their observations and ideas, that they were not able to include in the previous sections of the guide. The comments section would enable a consultant and a client to select their viewing and sharing options. The options available would include: "enable the consultant to view comments content," "enable a client to view comments content." It would also allow the users to select areas of the comments section they want to share with each other. If, let's say, the consultant has written down a list of possible issues with the client's information system, but only wants to share a couple of them with the client, the consultant would be able to select exactly what to share.

One of the RE components, document-centric requirements engineering methods, focus on assuring that the important information can be retrieved by using a system archeology [20]. Although this paper proposes an innovative approach to

requirements engineering, it also possesses document-centric methods. The "version no" section enables users to keep track of changes made over time. It is an important aspect of documentation, as it assures that important information can be retrieved whenever needed. Changes to any section of the guides can be made at any time of the project, which would trigger a new "version no" identification and the modified texts would appear in bold. The changes can thus be effectively traced and efficiently reviewed.

4. 3. Step 2: Activity information guide

The second step of EREM enables a consultant and a client to gather information about an activity or function of an organization. The aim of this procedure is to allow a consultant and a client to state the high-level activity goals and their constraints. It also seeks to verify that the activity goals align with an IS project's goals. This step also lists down the activity's processes as a preparation for the following step. The second guide contains different components organized in sections, including general activity information, activity stakeholders, activity goals and alignment, and activity processes and scores, which will be discussed in detail later in this sub-subsection.

Like the "general background information" gathered in the first step of the EREM process, the activity guide section begins with providing general information about one of the main activities of a client's organization. Each main activity will have a separate activity guide entry. The activity name, acronym and activity ID will be created for reference. The activity description will provide more details on the

functions of the activity, and include a list of technologies affected by the activity. The activity's duration or life cycle and its performance dependency on other activities are also stated. The scenario feature provides an example of a possible situation that can arise during the process of the activity. Scenarios have been proven to show flexibility in eliciting requirements and ensuring consultant's understanding of events and even the sequence of related events [30]. The scenario will have to be very explicit to minimize any misconception or misunderstanding. Furthermore, this guide will also have the same “comments,” “accountable,” and “version no” features as the first step of EREM.

4. 3. 1. Activity stakeholder

The activity stakeholders include all the internal and external stakeholders that are involved in an activity. The categorization of the internal and external stakeholders is like the first step of the EREM’s guide. The primary stakeholders involve the IT staff members participating in the activity, the secondary stakeholders include the stakeholders most affected by the activity, and the tertiary stakeholders are individuals who are only minimally affected by the activity.

If new stakeholders are identified during the second step of EREM, a user (either the consultant or the client) would be prompted to edit the first guide. Once the changes are implemented on the first guide, the user would be able to continue where they left off on the second guide. If additional changes are also necessary, the system will prompt the user to edit those sections accordingly. This type of flexibility would

enable consultants and their clients to edit their documentation throughout an IS project freely.

4. 3. 2. Activity goal and alignment

The activity goal entails the purpose and aim of an activity. To determine an activity's goal, the individual filling out the form should clearly explain the purpose and the importance of the activity. This would provide an initial depiction of the user's perception of the aim and value of the activity. Like the project goal feature, the constraints and success measurement criteria will also be included.

The alignment feature is a measure that verifies whether an activity aligns with a client's goals and their project goal(s). According to an article, the main objective of strategic IT-business alignment is to ensure that the implementation of IT related resources align with the organization's strategic goals [5]. The lack of IT business alignments could be very time-consuming and lead to significant financial losses [5]. As such, verifying that the activity goals align with the client goals and project goals is important. There are three options for both client goals and project goals: "yes," "partly," and "no." Then, the user will be prompted to provide an explanation for the selection of one of the available options.

4. 3. 3. Activity processes and scores

This feature resembles the list of activities mentioned in the first step. The only difference is, instead of creating a list of activities, this feature focuses on providing a list of processes associated with the completion of an activity. A process, for this

thesis, involves the different procedures that are taken to accomplish an activity's goal. Each process will be further analyzed in the third step of the EREM process. Each mentioned process will also have a specific accountable individual. They are listed in the order of their commonality by the users.

The second guide additionally displays an activity's performance results as a score in a percentage format. An activity's score considers its effectiveness, efficiency, and value performance scores. Scores that have a high percentage, meaning above 80%, signify that the activity is performing well, activity scores that are between 50% and 79% need to be re-evaluated, whereas activities that have less than 49% are in critical condition. More of the details about the scores analysis will be provided in the fourth step of EREM. This section is also automatically completed by the system after each scorecard on the third step of the EREM process is completed.

4. 4. Step 3: Process information guide

The third step of EREM involves an in-depth analysis of each activity's processes. The aim of this phase is threefold. First, this phase breaks down and analyzes the events that take place to achieve an activity's goal. It also presents the results in the form of diagrams to validate the gathered information. Second, it measures the IS performance of the entire process based on four key determinants: the efficiency, effectiveness, value, and commonality of a process. Finally, this phase helps its users gather the system and user requirements of that process. The third guide contains different components, organized in sections, including process procedures,

scorecards, data collected and critical technologies, process requirements, process scoring method, which will be discussed in detail later in this sub-subsection.

The process information guide begins with the collection of general process information like the previous two steps of the EREM process. The main person who is responsible for filling out this form is the accountable person mentioned in the activity guide. The process name, acronym and process ID are created using the same methods as the activity guide. Information about the process associated activity is also included for reference. Those include the activity name, acronym and activity ID. The process description provides a general overview of the process, including the type of technology affected and the duration of the process. Also, the "process goal," "comments," "accountable" and "version" features follow the same methods as the second step of EREM.

4. 4. 1. Process procedures, data collected, and critical technologies

A process accountable individual, in this section, will map the flow of events of a process. The information entered by the accountable individual will be displayed on the split screen of the system, to enable the user to visualize the process. The mapping process was inspired by a research, where the authors used a variation of the Goal-oriented Requirements Language (GRL), a method used to document and model the gathered requirements [37]. The authors used four main categories (Goal, Task, Resource, Actor) to map the relationship between those categories and the requirements [37]. On this guide, the processes are represented using a hierarchical

numbering method that triggers a new event, stating actors that affect or are affected by the event, and technological resources used to collect data during the event. An event, for this thesis, is a manual or automated, procedure or an action that takes place to complete a process. The technology category refers to systems that collect data or provide information during an event. Entities created by the technological tools will be specified. An entity is an individual, location, item, department or thing, which data is used during an event.

The visualization aspect of a process enables users to analyze and validate each event. The diagrams also help users elicit requirements to increase the efficiency, effectiveness, and value of each event within a process. This method is considered a mind-mapping requirements elicitation method and a requirements validation method [20]. Research has shown that both the consultant and the client benefit from drawing or sketching requirements. Indeed, they mention it helps foster creativity and simplifies communication and understanding between the project stakeholders and the consultant [23].

The “data collected” feature provides a list of data collected for each entity mentioned in the procedure of a process. An entity can be an individual, an item or any element that has distinct identifiable characteristics. The purpose of this feature is to enable a consultant and an accountable person to see if the missing data could be added into a system. Missing data can be added onto the effectiveness requirements list.

The critical technology feature shows systems that have many requirements. This is determined in two ways: subjective and automated method. The system will detect and create a list of the most mentioned technology systems in the process. The accountable individual and the consultant will then determine which system needs more requirements to optimize its performance. Once the system is selected (multiple systems can be chosen), the cost associated with the system is analyzed. Since the budget type of different organizations varies, each client will have their own definition of what is costly. The system will provide three cost options: high, medium, low. A high price will have a cost score of 100%, a medium or an average cost will have a 50% rating, and a low cost will have a 0% score. The scores represent their importance in determining the cost-benefit of a system within a process. They are also used to calculate every activity's requirements urgency score, which will be later discussed in the fourth step of the EREM's process.

4. 4. 2. Process requirements

Measuring an IS process by using a multidimensional method, enables users to gather requirements that address various important aspects of an IS [17]. This feature attempts to accomplish that by focusing on four different dimensions or categories: the efficiency, effectiveness, and value of a process. The efficiency and effectiveness categories are measured by the user and system performance subcategories, while the value category is measured by the process alignment, competitive advantage, sustainability and growth, and maturity and innovation sub-categories. In addition,

each created requirement is categorized as "mandatory" or "optional," determined by an accountable individual and a consultant. A mandatory requirement means that the requirement is necessary and needs to be implemented to increase the IS performance of a process or a system. On the other hand, an optional requirement signifies its implementation would "be nice to have," but the organization does not consider it to be "a must." Every requirement will also be written using natural language. The statements will have to be short but clear enough for all stakeholders to understand. The requirements should also clarify their purpose and what/who their implementation will affect.

Each process is evaluated against the multidimensional aspects of an IS, including the efficiency, effectiveness, and value dimensions. Scorecards are used to measure each dimension's IS performance based on select key dimension criteria. A user will rate a process' IS performance against each criterion by using a rating scale. For every scorecard criterion that has a score less than 4 out of 5, a user enters a new requirement into the guide. The details of the scorecard calculation methods and requirement types are explained below.

4. 4. 3. Process scoring method

The process score represents the overall performance score of a process. Indeed, it is the average combined score of the efficiency, effectiveness, value and commonality scores. The process score is presented in a percentage format. A high percentage score signifies that a process is valuable and performing well. The commonality score

is manually added by a client and represents how common or how often this process is used compared to the other processes within the same activity. The efficiency, effectiveness and value scores are determined using scorecards. A process IS performance is measured against each scorecard criterion based on a rating scale of 1 to 5, with (1) poor, (2) less than average, (3) neutral, (4) very good and (5) excellent. The average score of those criteria is then automatically calculated.

The efficiency dimension represents the optimal productivity performance of a process with minimum expense required. Different criteria have been selected to specify its characteristics. Most of the user requirements' efficiency criteria are measured by the minimal effort, time, and users required to complete a task [5, 9,11,63]. A system's efficiency is measured by the minimum amount of time and effort needed to collaborate, communicate, use, and learn the system [5, 7, 17, 18, 31]. The system's efficiency is also measured by its optimal productivity performance including the system's flexibility, mobility, and minimal errors created [3, 4, 13, 14, 15, 17, 39, 41]. The system requirements of the efficiency category fall under non-functional requirements because these requirements explain how a system attempts to accomplish a task.

The effectiveness category measures a process' ability to achieve its goal. Like the efficiency category mentioned above, two subcategories were selected to measure the effectiveness of a process: the system and user requirements. The selected criteria to measure the system's performance include its usability, workload capacity,

scalability, search ability, and ability to improve decision-making [4, 10, 15, 17, 29, 41]. In addition, the efficacy of information retrieved from the system is measured by its relevance, completeness, reliability, usefulness, customizability, security, and its ability to provide up to date and real-time information [3, 15, 17, 18, 29, 41, 64]. The user requirements' efficacy performance measurement includes their work productivity, performance traceability, work transparency, work usefulness, minimal risk involved to their work's success, and satisfaction of all the system's users [5, 7, 14, 17, 18, 41, 64]. The system requirements of the effectiveness category, compared to the efficiency category, are based on functional requirements because they explain what a system is attempting to do, to accomplish a task.

The value category measures the importance and benefits of a process' IS. Unlike the efficiency and effectiveness categories, the value category has four subcategories: alignment; growth, learning, and maturity; sustainability and competitive advantage. A process' information system is considered valuable if it aligns its users' skills to its associated tasks, goals, and priorities [5, 12, 13, 14, 37]. Furthermore, a process' information system is valuable if it fosters an organization's growth, maturity, and innovation ability by having a documentation system, offering proper training, providing access to latest technology and having room for improvement [6, 7, 10, 17, 27, 65]. Research also shows that events that are sustainable add value to an IS process by using renewable energy sources, being cost-beneficial, using minimal number of resources and clearly defining every stakeholder's' roles and

responsibilities [3, 4, 5, 8, 11, 31, 33, 44]. Finally, a process' IS provides a competitive advantage if it benefits the work culture, boosts an organization's reputation and increases an overall service quality [7, 9, 17, 18, 64, 72].

4. 5. Step 4: Requirements analysis information guide

The main goal of the final EREM step is to provide an analysis of the gathered requirements from the previous steps. Namely, this section aims to prioritize requirements based on key IS determinants including an activity's technological costs, IS performance, and overall importance. This section also provides a "critical activity requirements" score, to effectively optimize the requirements engineering process. Furthermore, it enables a consultant and a client to review the suggestions on how to proceed with the activity systems. The last guide contains different components organized in sections, including critical activities, processes and technologies prioritization, overall efficiency, effectiveness, value and commonality scores, and visual representations, which will be discussed in detail later in this sub-subsection.

4. 5. 1. Critical activities, processes and technologies prioritization

The critical activities prioritization section of the final guide organizes the client's activities in the order of urgency. This means that the first activity's requirements are more critical and urgent than the last activity of the list. Each activity is given a score and organized using a critical activity score equation. The equation considers each activity's score, importance score, and technology cost. The equation also considers the weight given to each score based on the client's prioritization goals. A critical

activity would have a low activity score, a high importance score, and a high technology cost score.

$$CriticalA_{score} = \frac{(1 - \mathrm{Aw_x}) + \mathrm{Iw_y} + \mathrm{Tw_z}}{\mathrm{w_x} * \mathrm{w_y} * \mathrm{w_z}}$$

A, I, T, and w denote activity score, importance score, technology score, and weight score, respectively. The subscripts x, y, and z denote the prioritization of the weight scores as determined by a client.

The activity score is automatically computed based on the average of an activity's process' scores. Hence, it measures the activity's process' IS performance. The importance score is based on the accountable individual's perspective (from the first guide) on the importance of the activity to the client's overall goals, as mentioned in step 1. Similarly, the technology cost score is determined from the activity's accountable individual's perspective on critical technology systems used in an activity's processes (step 2 & 3).

On the other hand, the critical process prioritization considers the average of each process efficiency, effectiveness, and value scores. The processes are then organized in the order of the lowest process score. In contrast, the critical technologies prioritization feature lists down all the critical technologies identified in the previous steps that require attention. Each system is given one of three options: keep, replace or remove. If a system is marked as "replace" it means that the system is not

performing well, it is expensive and upgrading the system or replacing it with another one is necessary. If a system is marked as "remove," the system is considered not cost-beneficial or important to the process of an activity. On the other hand, if a system is marked as "keep," it means that the system is important and cost-beneficial. The three options are determined automatically by the system using an equation called the critical system score.

The critical score equation considers the "high" or "low" scores of three elements, including the number of requirements a system has, the costs associated with the system and the number of processes affected by the system. To determine if an element is scored "high" or "low," the average number of an item's score is calculated, and all the scores that are above the mean are considered "high," while scores that are equal or less than the mean are considered "low." A system that needs to be replaced would have a significant number of requirements, it would be expensive and affect many processes. A system that needs to be removed would have a low number of requirements, a high cost and affect a low number of processes. A system that needs to be kept would have a low number of requirements, a low cost and impact a high number of processes.

Let:

$$R = \begin{cases} 100, if\ High \\ 0, if\ Low \end{cases} \qquad C = \begin{cases} 10, if\ High \\ 0, if\ Low \end{cases} \qquad P = \begin{cases} 1, if\ High \\ 0, if\ Low \end{cases}$$

$$Critical_{score} = R + C + P$$

If $itcal_{score} \geq 100$, then $Critcal_{score} = Replace_{score}$

If $10 \leq Critcal_{score} \leq 99$, then $Critcal_{score} = Remove_{score}$

If $itcal_{score} \leq 9$, then $Critcal_{score} = Keep_{score}$

R, C, P denote the requirements score, technology cost score, process score, respectively.

4. 5. 2. Overall efficiency, effectiveness, value and activities scores

The overall efficiency, effectiveness, value, and activities scores are the average scores of every activity's IS performance scores. Those scores enable a client to easily see the strength and weakness performance areas of their information system. It also allows them to create new requirements that are focused on specific categories.

Those scores will be displayed on the guides as well as through visual representations. EREM system users will be able to select their viewing options. The options available include relationship-based diagrams, single score-based diagrams, and color-coded tables. The users will also be able to click on a specific visual representation of the results, to access more detailed information on how those results came to be.

Chapter 5: Case Study

5. 1. Methodology

To demonstrate how EREM works and its practical implication, a case study was conducted with a medium-sized nonprofit organization ("NPO"), headquartered in Washington DC. The NPO also has another office located in New York, NY. About 250 of the NPO's employees work in its headquarters office, while approximately 50 employees work in New York. The organization was founded about two decades ago to help advance a larger non-profit international organization's goals. To accomplish this, the NPO builds partnerships, organizes resources, and advocates for policy changes.

The NPO uses the same IS in both offices. The NPO's information system is central to their daily operations. For instance, the organization relies heavily on its customer relationship management software, including Salesforce and Luminate Blackbaud, to accomplish their objectives. Almost every meeting is conducted using Skype for Business, to include employees, external partners, and other stakeholders in different meetings. Furthermore, daily, weekly, and monthly briefings are shared with stakeholders using various mediums, including email, intranet, websites, and social media platforms. Since many employees travel to multiple countries for assignment, it is critical for the organization to ensure that the employees have access to all their needed IS abroad. Therefore, the NPO uses its IT equipment loaning system, where

devices such as cell phones, tablets, laptops, MiFi's, and converters are provided to the employees after ensuring that the equipment is compatible to their travel destination. Thus, the employees can have access to software on the go. Hence, the management of the NPO's IS by their IT department plays a crucial role in ensuring that the organization's daily operations runs smoothly.

The research methods included the review of existing documentations and open-ended informal interviews and brainstorming sessions with the key stakeholders at the NPO. Both research methods, the review of existing documentation and the latter method were used interchangeably throughout the EREM process. The case study also followed the sequential methodology of EREM.

The interviews were conducted with seven NPO staff, namely four information technology staff members, and three department representatives from the communications, finance, and digital teams. From the IT staff, the interviewees included the IT executive director, the enterprise architect, the IT support staff manager, and one IT support specialist. The IT executive director was interviewed twice: once at the beginning of the project and again at the end of the case study to confirm the findings. The enterprise architect and the digital team representatives were interviewed at the same time in a brainstorming session. At another time, the communications team representatives and the enterprise architect were interviewed together. The rest of the staff members were interviewed independently. All

interviews were conducted in person, except for those with the enterprise architect as they were conducted via conference calls. Notes were taken actively throughout the interviews. Table 4 is a summary of the interviewees' demographics, requirements engineering experience, and interview duration.

Interviewee role (department)	**Gender**	**Age**	**Length of Job at NGO**	**Experience with RE**	**Interview duration**
IT Executive Director (IT)	Female	50-59	19 years	Familiar with RE concepts	Two 30mins
Enterprise Architect (IT)	Male	40-49	7 years (5 as a consultant to the NPO, 2 as a full-time employee)	Experienced with RE (10+ years of Enterprise architecture consulting experience using RE components to mostly elicit and validate requirements using interviews and prototypes)	1 hour with digital rep and 2 hours with communicatio n rep
IT Staff Manager (IT)	Male	30-39	3 years	No experience	1 hour
IT Support Specialist (IT)	Male	30-39	3 years	No experience	30 min
Digital Team rep (Digital)	Female	30-39	1 year	Familiar with RE concepts	1 hour with enterprise architect
Finance Team rep (Finance)	Female	40-49	10 years	No experience	30 min
Communications Team rep (Communications)	Female	30-39	5 years	No experience	2 hours with enterprise architect

Table 4: Case Study's interviewees' demographics and interview questions

Interview questions were developed using key components of each guide. An interview question bank was then created to address those components and to help gather information that may not be straightforward for a consultant (see Appendix A). The question bank has different categories to enable a consultant to easily select questions to ask. Some questions have follow-up questions that would help gather more detailed information on a specific feature of a guide. The interviews were aimed to increase the overall understanding of how the NPO functions. Hence, most of the questions focused on asking open-ended investigative questions. They would generally begin with a "what," followed by a "how" and a "why." For example, the "what" centered questions enabled identifying different activities, while the "how" questions would explain how an activity functions, and the "why" questions would help determine the purpose and importance of that activity.

Two types of documentations were used: documentations gathered through external sources and documentations provided by the NPO. The external sources included the NPO's website and their social media accounts. The documentations provided by the NPO included the IT processes' documentations, previously gathered requirements to build their intranet, and summaries of the organization's staff structure and functionalities.

5. 2. Step 1: Background information

The NPO builds partnerships, organizes resources and advocates for policy changes to support a larger global nonprofit organization. Recently, the overall financial

assistance the NPO received has been steadily decreasing compared to the first ten years of its founding. As a result, the NPO had to have department-wide budget cuts. Indeed, every department was tasked with reducing costs on their expenses and finding better ways to become more efficient and effective. The executives of the organization additionally encouraged their staff members to adopt latest technological tools to simplify their daily tasks and reduce their expenses. Hence, in addition to helping the organization have a better IS and access to IT tools, the information technology department also had to find ways to reduce their overall expenditures. The background information guide summary is displayed in Table 5.

5. 2. 1. Client stakeholders, office culture and main activities

Different external and internal stakeholders were identified. The external stakeholders include, donors, organization partners, U.S brand ambassadors, board members, global nonprofit organization and various governments, respectively (in order of their importance). In comparison, the internal stakeholders include the IT executive director, IT staff manager, and IT support staff from the IT department. The primary project stakeholders include the IT Executive Director, IT staff manager, and the enterprise architect. The secondary stakeholders include the digital team staff member, communications staff member, HR staff member, and finance staff member. The tertiary stakeholders were IT support staff members and the digital team staff members.

The organization of the case study falls into the clan office culture type. Indeed, the employees heavily rely on collaboration with their co-workers to achieve results and support one another. While the NPO does not have specific IS measurement tools, the IS performance success is generally measured by how effective the IT department is at satisfying all the NPO's staff's technology-related needs. However, at the executive level, their expectancies vary. The higher- level management executives expect the IT department to become more efficient and effective at providing IT-related services. In other words, the higher-level management executives expect the IT department to adopt a hierarchy-type of office culture. While the various culture types help identify the differences in the expectations and representation of actual circumstances, the authors of a research mention that a great leader would encompass all the office cultures [72]. As such, the IT department might have to re-evaluate the culture type they enforce in their department.

The interview with IT executive director and the review of documentation on the IT staff structure helped identify the organization's main activities. Those include:

- IT support (IT help for staff that experience technical difficulties), IT training (orientation for new staff members)
- IT security (network, data and information security)
- Database management (managing multiple databases)
- IT projects (such as implementing software and building intranet)
- IT equipment (loaning technological devices to staff).

The IT staff manager is accountable for both IT support and IT training. The network administrator is accountable for the IT security function and the database management activity. The database manager is responsible for the management of databases and IT equipment loans. The enterprise architect is responsible for managing IT projects and the database management activity. The IT project coordinator is responsible for managing IT projects. Multiple individuals seem to oversee various activities which could both be beneficial and an impediment for the IT department.

5. 2. 2. Client goals and problem statement

The organization's mission statement focuses on providing support to the efforts of a global organization. The objectives of the organization include advocating for various campaigns, organizing resources, building partnerships, and growing constituencies. The IT department's continuous goal is to support the organization's staff members by providing efficient and effective technological resources.

The constraints of the project are based on the duration of the project and the staff availability to respond to questions. Three project success measurement criteria were determined: obtaining a higher performance evaluation score from the executive management executives, satisfying employees' needs by getting positive feedback from HR, and reduce the number of IT tickets, respectively. The roles and responsibilities of the client and the consultant were also discussed but not included

in the guide. The consultant was expected to gather requirements from interviewing accountable individuals and validate them with the IT executive director.

The IT executive director explained that the HR department received complaints from employees for not receiving adequate IT training and having to rely on the IT team constantly. The executives also received complaints from employees that their IT-related issues were not solved promptly, which they reported back to her. Also, when the IT team tried to cut costs on their expenses they discovered that some of the most expensive IT tools were outdated and they assumed that they were not being used. Hence, she believed the department needed to update their tech tools, automate processes, reduce time to respond to IT tickets and find new IT training methods. They had previously tried to provide meeting-style trainings to the organization's staff as well as weekly tips via email and intranet. She explained that there was not a large turnout for the meetings and her team has not received feedback on the IT tips provided using those mediums.

5. 2. 3. Background information guide summary

Table 5 is the overview of the information collected from the first step of EREM using the guide, documentation, and interview responses as guides. While some of the labels are quite self-explanatory, each label will have an informative help guide for its users. In the case study, since this is a conceptual model, the comments were focused on observations from the interview with the IT executive director and were not shared with her. During the interview, it was clear that the organization employs a clan office

culture, but that has hindered them from clearly defining everyone's roles and responsibilities. This was particularly observed when questions about possible project stakeholders were asked. The executive director was not sure on who to include as she explained that "everyone does a little bit of everything" at the organization.

Client Name: Non-Profit Organization **Acronym:** NPO **Client ID:** 001
Address: Washington, DC USA **Size:** medium **Founded:** 1990
Client type: Non-Profit **Specialties:** constituency, advocacy, policy change
Project start date: 01/01/2017 **Project ID:** 001
Cost spectrum: Low ($0-$999), Medium ($1,000-$4999), High ($5,000+)

Client goals:

- Mission (support the efforts of a global organization),
- Objectives (advocating on various campaigns, organizing resources, building partnerships and growing constituencies)

Stakeholders:

- External (donors, partners, U.S brand ambassadors, board members, global nonprofit organization and various international governments)
- Internal (IT executive director, the IT staff manager and IT support staff)

Office Culture:

- Actual(clan)
- Expectation (clan and hierarchy)

Problem statement:

- Discovery process (HR received staff complaints for inadequate IT training, executives received complaints from untimely tech support, IT team discovered costly and likely unused tech tools when trying to cut costs)
- Perceived issues (outdated tech tools, minimal tech tools usage, employees not retaining IT training materials)
- Perceived needs (update tech tools, reduce time spent on tickets, find new IT training method, automate processes)

• Past remedies and outcomes (provided meeting-style trainings (low turnout), provided weekly IT tips via email and the intranet (no feedback))
Project goal: • IT department goal **(**reduce IT cost, increase the organization's information systems effectiveness and efficiency) • Constraints (staff availability, time spent) • project success criteria (1. higher performance evaluation score from executive management; 2. satisfy employees' needs through HR's feedback; 3. reduce number of IT tickets) **Project stakeholders:** • Primary (IT Executive Director, IT manager, Enterprise architect) • Secondary (Digital Team staff member, Communications staff member, HR staff member, Finance staff member) • Tertiary (IT staff member, digital team staff member)
Activities: • IT support (IT staff manager), importance (high) • IT training (IT staff manager), importance (medium) • IT security (network administrator), importance (high) • Database management (enterprise architect, database manager, network administrator), importance (high) • IT projects (It project coordinator, enterprise architect), importance (high) • IT equipment loan (database manager, IT project coordinator), importance (low)
Comments: unclear roles and responsibilities of IT staff members
Accountable: IT Executive Director (signed), consultant (signed). **Version No:** 001

Table 5: Background information guide

5. 3. Step 2: Activity information

In the case study, each activity has been analyzed, but since the priority of the project goal is to increase the executive staff's performance evaluation of the IT department, the IT support activity will be discussed in detail. This is because the main reason

why the executive staff was dissatisfied with the IT department was related to the number of complaints they received about the untimely execution of IT tickets, which is handled by the IT support function of the office. Indeed, the IT support activity can be described as IS-related support that the IT staff provides to the rest of the organization. The type of IT support that activity provides varies and is limitless, but it mostly focuses on solving technical issues, setting up workstations, upgrading tech tools, loaning tech devices and setting tech devices for conferences. An example of a possible scenario could involve a staff member, who creates a ticket on the intranet to request the IT support team to help him or her fix a technical issue with upgrading software. The summary of the activity guide for the NPO is displayed in Table 6.

5. 3. 1. Activity goal and alignment

The IT support's goal of the case study is to simplify staff members' daily tasks with technological support. By simplifying their tasks, the organization will become more efficient at reaching the organization's objectives and mission. The primary constraints and limitations of the activity are related the IT staff availability in answering IT help requests and their expertise in solving them. The organization's success performance is measured by the minimum average amount of time it takes the IT staff to resolve IT support requests and the positive feedback they receive from executives by satisfying the employees' needs. In the case study, the activity’s goals partly align with the client’s organizational goals, as they increase the overall efficiency of the organization by simplifying the tasks of the organization staff. The activity’s goals also align with the project goal since one of the main issues stated in

the problem statement of the first step was the untimeliness of the completion of IT support requests.

5. 3. 2. Activity stakeholders and accountable individuals

The IT staff manager is accountable for every process associated with the IT support activity. There are four types of processes associated with this activity and are generally different ways that staff members can request help from the IT department. In the order of their commonality, the processes include: physically asking for help (by either going to the IT department or talking to an IT staff member whenever they see them), sending an email to the IT support group, making a phone call to make an IT request, and creating an IT ticket using an intranet link.

The IT support staff members are responsible for managing all IT support related activities, and the IT staff manager is accountable for the team's performance. The rest of the organization staff members are the ones who send IT support requests to the IT department. External stakeholders, partners, and board members, who are mostly conference attendees at the organization, can also request IT support.

5. 3. 3. Activity information guide summary

Activity Name: IT support	**Acronym:** IT_S	**Activity ID:** 001
Activity Description: • Details (IT staff provides IT support to all staff) • Affected technology (intranet (SharePoint), email (Outlook), ticketing system (ManageEngine), Skype for Business, K1000, Bomgar, Office 365) • Duration (length of IT support request process, generally solved within half a day)		

• Dependency other activities (n/a). **Scenario:** a CSNPO staff member's computer freezes too often, so the staff reports the issue to the IT department by issuing an IT ticket, and an IT support staff member solved the issue.
Activity stakeholders: • Primary (IT support staff, IT staff manager) • Secondary (CSNPO staff) • Tertiary (partners, board members)
Activity goal: • Activity goal (simplify staff members' daily tasks with technological support) • Constraints (dependent on staff availability, staff technological expertise) • Success measurement criteria (1. handle IT tickets promptly; 2. positive feedback from executives in satisfying employees' needs) **Alignment:** • Client goals (partly, simplification of tasks with IT support increases efficiency of the organization) • Project goal (yes, untimely IT support reported)
List of processes: • Physically asking for help (commonality: 4/4; accountable: IT staff manager) • Sending IT support email (commonality: 3/4; accountable: IT staff manager) • Making a phone call (commonality: 2/4; accountable: IT staff manager) • Using the intranet to make a request (commonality: 1/4; accountable: IT staff manager)
Efficiency score: 59% **Effectiveness score:** 58% **Value score:** 59%
Activity score: 60%
Critical technology: ticketing system (cost: high)
Comments: unclear roles and responsibilities
Accountable: IT Staff Manager (signed), consultant signed). **Version No:** 001

Table 6: Activity information guide

5. 4. Step 3: Process information guide

The IT support request process sent through the intranet has multiple steps, as shown in Figures 3 and 4. First, a staff member creates a ticket using a link on the intranet.

Then, the entire IT support staff receives an email notification of the creation of a new ticket in ManageEngine, their IT ticketing system. The system evaluates the ticket, assigns it to an IT support staff, and sends an email notification to a designated IT support staff for the assignment. The designated IT support staff will decide on whether to accept the assignment or designate it to another IT support staff using the ticketing system. If the latter is selected, the process is repeated. If the designated IT, support staff accepts the assignment, on the ticketing system, or by email, and he or she will either physically go to the ticket creator's workstation or virtually assist them. The most the most common tech tools in this process include: Bomgar (to remotely access a desktop), K1000 (for IT equipment loaners), Active Directory (to manage network components), Skype for Business (to find the employee's workstations) and Office 365 (to set up new hires with their tech needs). Finally, the assigned IT staff marks the ticket as solved on the ticketing system or by sending an email to the IT support team. The process procedure is also described in Table 10. Tables 7, 8, and 9 provide the process efficiency, effectiveness, and value scorecards' results.

5. 4. 1. Process efficiency, effectiveness and value performance scorecard results

Efficiency category	**Criteria [sources]**	**Criteria Score**	**Average category score**
User Requirements	process requires minimum effort [9], [63]	4	3.33
	process is not time consuming [5]	3	
	process needs minimum actors [5], [11]	3	
System Requirements	system is mostly automated [4], [13]	2	3.00
	system enables mobility [3], [41]	1	
	system minimizes errors [4], [39]	2	

	system has flexible data structures [14], [15], [17], [41]	2	
	system simplifies communication [5], [18]	4	
	system simplifies collaboration [31], [7]	4	
	system requires minimum learning/skill [17]	4	
	information can be accessed in timely manner [17], [18]	5	
	Efficiency score:	3.17	63%

Table 7: Efficiency Performance Scorecard of Process ID 001 (using the intranet)

Effectiveness category	**Criteria [source]**	**Criteria Score**	**Average category score**
User Requirements	process increases productivity [7], [18]	4	3.38
	process is useful [18]	5	
	process performance is traceable [17], [64]	4	
	process failure is least likely to impede organizational goals	2	
	process adapts to urgent situations [14], [17], [41]	3	
	process provides maximum transparency [5], [7]	4	
	primary actors are satisfied [7], [18]	4	
	secondary actors are satisfied [7], [18]	1	
System Requirements	system is easy to use [17], [18]	4	3.54
	system can handle various workload [41]	5	
	easy to search in the system [15], [29]	1	
	system is scalable [15]	4	
	system improves decision making [4], [10], [15], [18]	3	
	system provides real-time information [15], [29]	5	
	information is relevant [18], [64]	4	
	information is complete [18], [64]	2	
	information is reliable [17], [18], [64]	5	
	information is up-to-date [15]	4	
	information gathered is useful [17]	4	

	customized personalized information can be accessed [18]	2	
	secures privacy and confidentially of data [3], [18], [41]	3	
		Effectiveness score:	3.46	69%

Table 8: Effectiveness Performance Scorecard of Process 001(using the intranet)

Value category	**Criteria [source]**	**Criteria Score**	**Average category score**
Alignment	process goals align with the main activity goals [12], [13], [14], [37]	4	2.33
	process priorities are aligned with activity goals [5]	1	
	Professionals' skills align with the process requirements [5]	2	
Growth, learning and maturity	process is well documented [6], [10], [27]	2	2.50
	process has specific training session [17], [65]	1	
	process uses latest technology [10]	2	
	process has room for improvement and innovation [6], [7]	5	
Sustainability	process uses renewable energy sources [4]	4	2.25
	process is cost-beneficial [3], [5], [8], [33], [44]	1	
	process uses minimum resources [5], [11], [31]	2	
	stakeholders' roles, responsibilities and authorities are clearly defined [3], [24]	2	
Competitive advantage	process benefits the work culture [72]	2	3.67
	process boosts reputation [64]	4	
	process increases overall service quality [7], [9], [17], [18]	5	
	Value score:	2.69	54%

Table 9: Value Performance Scorecard of Process 001 (using the intranet)

5. 4. 2. Process information guide summary

Process information guide
Process Name: IT support request via Intranet **Acronym:** Ticket_Intranet **Process ID:** 001
Affected Activity Name: IT support **Acronym:** IT_S **Activity ID:** 001
Process Description: • Details (process that enables staff members to request IT support for various reasons via intranet) • Affected technology (intranet, email, ticketing system, Skype for Business, K1000, Bomgar, Office 365) • Duration (length of a ticket, about half a day)
Process goal: • Process goal (simplify IT ticket process, measure IT support activity) • Constraints (dependent on staff availability, staff technological expertise, staff memory) • Success measurement criteria (1. handle IT tickets promptly; 2. positive reviews)
Procedure: 1. Event (new IT ticket created), Actors (staff member), Technology (intranet: ticket, staff member; ticketing system: ticket, staff member), Next event (2) 2. Event (new IT ticket notification sent), Actors (IT support staff), Technology (ticketing system: ticket, IT support staff, staff member; email: IT support staff, ticket, staff member), Next event (3) 3.1. Event (IT ticket assigned to IT support member), Actors (IT support staff), Technology (ticketing system: ticket, IT support staff, staff member; email: IT support staff, ticket, staff member), Next event (3.2 or 4). 3.2. Event (IT ticket re-assigned to another IT support member), Actors (IT support staff), Technology (ticketing system: ticket, IT support staff, staff member, email: IT support staff, ticket, staff member), Next event (3.1). 4. Event (IT ticket accepted), Actors (IT support staff), Technology (ticketing system: ticket, IT support staff, staff member; email: IT support staff, ticket, staff member), Next event (5.1 or 5.2). 5. 1. Event (IT ticket solved physically), Actors (IT support staff member, staff member), Technology (Skype for Business: staff member, workstation), Next event (6). 5.2. Event (IT ticket solved virtually), Actors (IT support staff, staff member), Technology (email: IT support staff, staff member, ticket; Bomgar: workstation, Office 365: staff) Next event (6).

6. Event (IT ticket marked completed), Actors (IT support staff member), Technology (email: IT support staff, staff member, IT ticket, ticketing system: IT support staff, staff member, IT ticket), Next task (n/a).

Data collected:

- Ticket (name, ticket ID, staff member name, staff member email, priority, assigned staff member name, assigned staff member email, not assigned staff member names, assigned staff member emails, date created, time created, status of ticket, ticket description, ticket history, timer),
- Staff member (name, ticket name, workstation number, email, department),
- IT support staff (names, email address, skills, list of names of tickets pending),
- IT support team (names, email addresses, skills, list of names of tickets pending),
- Workstation (desktop virtual session number, workstation number, department)

Efficiency requirements:

- User (Mandatory: a limited amount of time (2 hours?) should be set to handle tickets (ticketing system) to increase service quality and secondary stakeholders' satisfaction; re-assignments should be made within a limited amount of time (1 hour?) to increase service quality, primary stakeholders' productivity and secondary stakeholders' satisfaction (ticketing system); Optional: a limit of the number of re-assignments should be created to reduce unanswered tickets and increase primary stakeholders' productivity. (ticketing system))
- System (Mandatory: new ticket notifications should only be sent to assigned individuals to reduce unanswered tickets and increase primary stakeholders productivity (ticketing system, email); IT support skills specification need to be added to minimize errors to reduce unanswered tickets, increase primary stakeholders productivity (ticketing system), system should have flexible data structures to simplify data mining purposes (ticketing system); Optional: IT support staff should be able to use the system on the go to increase their productivity (ticketing system))

Effectiveness requirements:

- User (Mandatory: unsolved tickets should be elevated to the manager in a timely manner to increase service quality (ticketing system), urgent matters should notify the manager and the assigned individual to reduce risks associated from impeding organizational goals (ticketing system, email), feedback method from ticket creator on performance of the designated should be included to improve service quality (ticketing system))
- System (Mandatory: system should have a functional search tool to increase primary stakeholders' productivity, specific performance measures should be created to improve secondary satisfaction and primary stakeholders performance(ticketing system), information about each entity should be

complete to reduce the use of different systems to access all of an entity's data (ticketing system, Office 365, email); Optional: system should enable users to customize user's view to increase their viewing experience and improve their productivity(ticketing system), system should increase the security of data collected to limit confidential information of secondary and tertiary stakeholders(ticketing system))
Value requirements: • Alignment (Mandatory: professional skills should align with the ticket assignment to reduce the completion time of a ticket and optimize primary stakeholders' capabilities; priorities standard should be created to additionally prioritize secondary and tertiary stakeholders (ticketing system)) • Growth, learning and maturity (Mandatory: every ticket should describe the process used to handle it to enable all primary stakeholders to increase their knowledge (ticketing system), specific training on how to use the system should be created to enable new primary stakeholders to have a point of reference (Office 365), system needs to be upgraded to access more useful information and service (ticketing system) • Sustainability (Mandatory: process should be less expensive, process should minimize the number of resources affected to optimize the efficiency and effectiveness of a system, actor's roles and responsibilities need to be clearly defined to reduce too many responsibilities on select primary stakeholders) • Competitive advantage (Mandatory: process needs to adopt both a hierarchical and clan CVF)
Critical technology: ticketing system (cost high)
Efficiency score: 63% **Effectiveness score:** 69% **Value score:** 54% **Commonality:** 25%
Process score: 53%
Comments: no reminders, no follow-ups, no measurement of success, repetitive, no pop-up timer, limited skills, difficulty to target right team member, management of data needs to be added such as assignment of tech devices database into ticket system
Accountable: IT Staff Manager (signed), consultant (signed). **Version No:** 001

Table 10: Process information guide

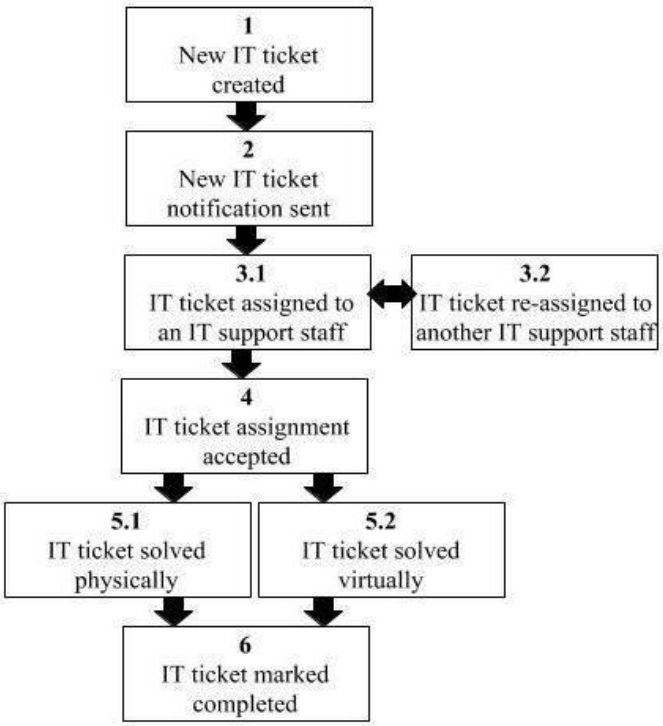

Figure 3: Process 001 procedure

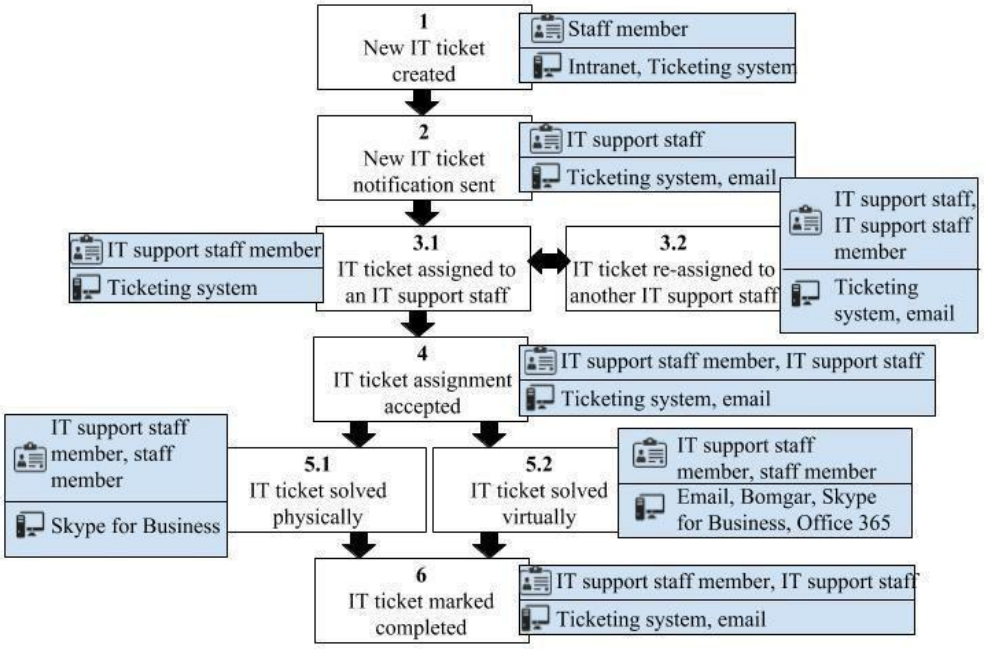

Figure 4: Process 001 procedure, actors, and technology systems

5. 5. Step 4: Requirements analysis

The organization's IT executive director chose to distribute the weights of the critical activity's elements in the following order: activity performance score has a weight of 3 out of 3, technology cost score has a weight of 3 out of 3, and the importance category has a weight of 2 out of 3. By using the equation, the IT support activity came in first place. The IT support activity has a performance score of 59.74% and a technology cost score of 100%. From the IT support activity, the "via intranet" process came in first place. Its performance score is 53% and has a technology score of 100%. Amongst the technology systems, the ticketing system came in first place. It has 23 requirements, a technology score of 100%, and an importance score of 100%. The summary of the requirements analysis guide is shown in Table 11, whereas the visual diagrams of the results are shown in Figures 5-11.

5. 5. 1. Requirements analysis guide

Critical activities that affect the project goal:

1. IT support (score: 78%; importance: high; technology: ticketing system (cost: high))
2. Database management (score: 75%; importance: high; technology: Luminate Blackbaud (cost: high), Salesforce (cost: high))
3. IT Project (score: 71%; importance: high; technology: Luminate Blackbaud (cost: high), Salesforce (cost: high))
4. IT security (score: 56%; importance: medium; technology: intranet(medium)
5. IT equipment loan (score: 33%; importance: low; technology: K1000 (cost: low), ticketing system (cost: high))

Critical processes that affect the project goal (for Activity ID 001):

1. Using the intranet to make a request (53%; technology: intranet (cost: high))
2. Making a phone call (score: 58%; technology: Skype for Business (cost: low))

3. Physically asking for help (score: 59%; technology: ticketing system (cost: high)) 4. Sending IT support email (score: 69%; technology: Office 365 (cost: low))
Critical technologies: 1. Ticketing system (action: replace) 2. Luminate Blackbaud (action: replace) 3. Salesforce (action: replace) 4. Intranet (action: keep) 5. K1000 (action: remove) 6. Skype for Business (action: keep) 7. Office 365 (action: keep)
Overall efficiency score: 62% **Overall effectiveness score:** 56% **Overall value score:** 63%
Activities overall score: 64%
Comments: not all the mentioned problems are reflected
Accountable: IT Executive Director (signed), consultant (signed). **Version No:** 001

Table 11: Requirements analysis guide

5. 5. 2. Requirements analysis diagrams

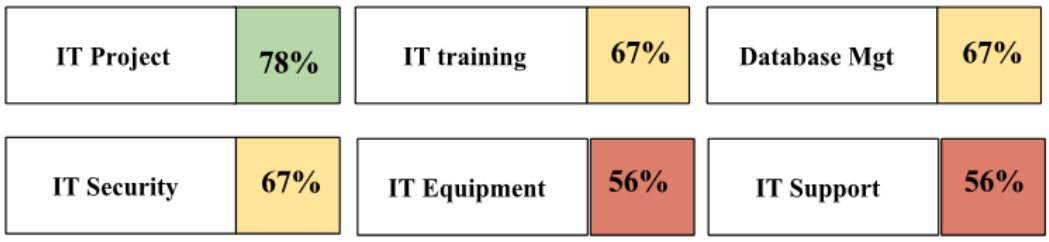

Figure 5: Best performing activities (with dependency)

IT Support			
Activ	Impo	Cost	Critical score
60%	100%	100%	
Effi	Effec	Value	78%
60%	58%	59%	

Database Mgt			
Activ	Impo	Cost	Critical score
67%	100%	100%	
Effi	Effec	Value	76%
60%	62%	68%	

IT Project			
Activ	Impo	Cost	Critical score
78%	100%	100%	
Effi	Effec	Value	71%
67%	66%	79%	

IT Security			
Activ	Impo	Cost	Critical score
67%	100%	50%	
Effi	Effec	Value	56%
66%	68%	69%	

IT Equipment			
Activ	Impo	Cost	Critical score
61%	0%	50%	
Effi	Effec	Value	33%
68%	67%	67%	

IT Training			
Activ	Impo	Cost	Critical score
67%	50%	0%	
Effi	Effec	Value	25%
74%	71%	75%	

Table Legend

= critical activities' requirements that need to be given priority

= activities' requirements that need to be addressed after critical activities' requirements

= activities' that should not be given priority

Activ =activity score;
Impo =activity importance;
Cost= technological costs of that activity;
Effi = efficiency score average of that activity;
Effec= effectiveness score of that activity;
Value= value score of that activity

Figure 6: Critical activities (with dependency)

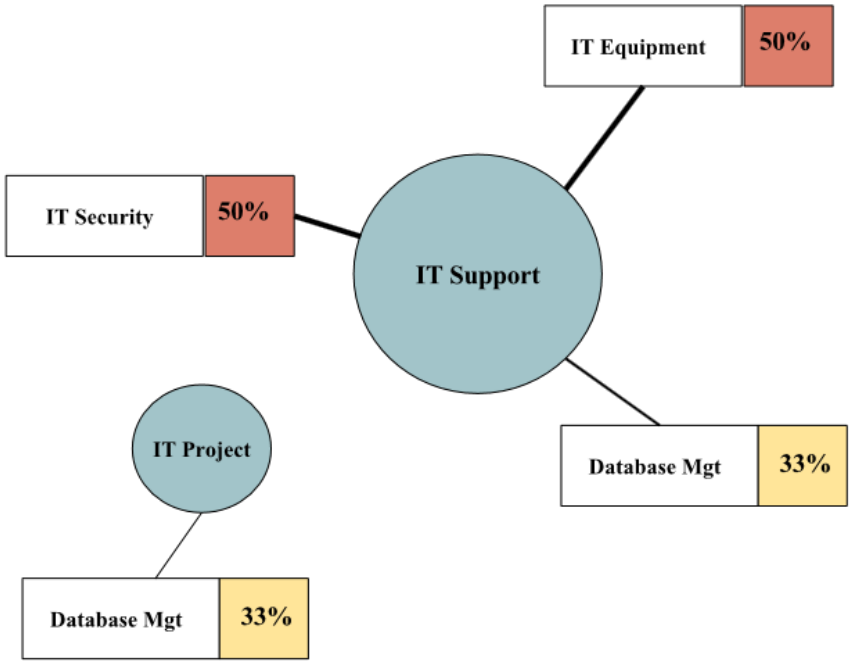

Figure 7: Activity performance dependency graph

IT Support			
Activ	Impo	Cost	Critical score
60%	100%	100%	
Effi	Effec	Value	78%
60%	58%	59%	

Database Mgt			
Activ	Impo	Cost	Critical score
64%	100%	100%	
Effi	Effec	Value	76%
54%	62%	65%	

IT Project			
Activ	Impo	Cost	Critical score
78%	100%	100%	
Effi	Effec	Value	71%
67%	66%	79%	

IT Security			
Activ	Impo	Cost	Critical score
74%	100%	50%	
Effi	Effec	Value	54%
72%	77%	79%	

IT Equipment			
Activ	Impo	Cost	Critical score
61%	0%	50%	
Effi	Effec	Value	33%
75%	75%	75%	

IT Training			
Activ	Impo	Cost	Critical score
67%	50%	0%	
Effi	Effec	Value	25%
74%	71%	75%	

Figure 8: Critical activities (without dependency)

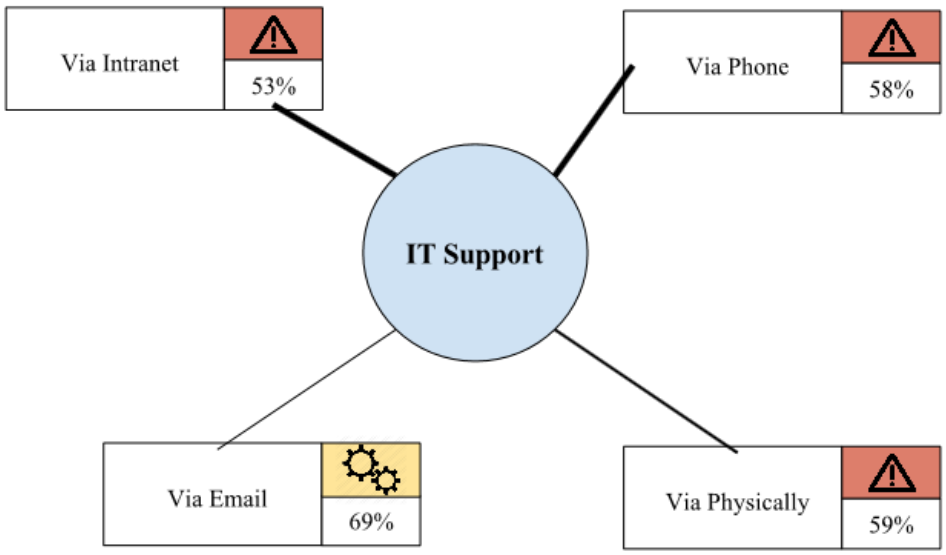

Figure 9: Critical processes

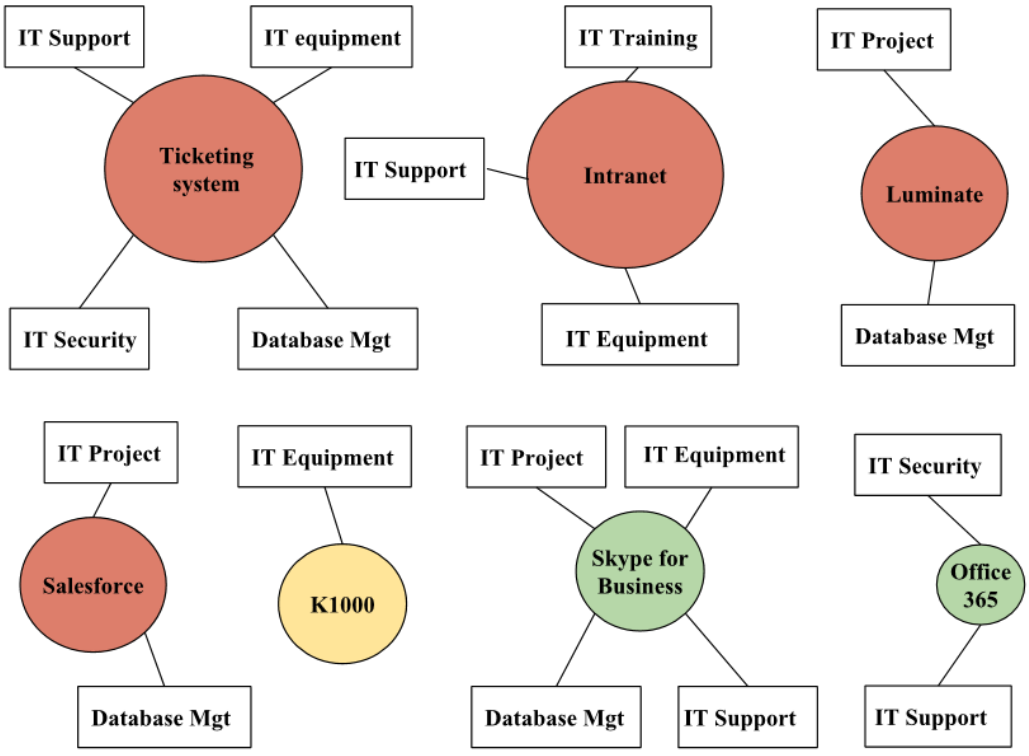

Figure 10: Technology systems

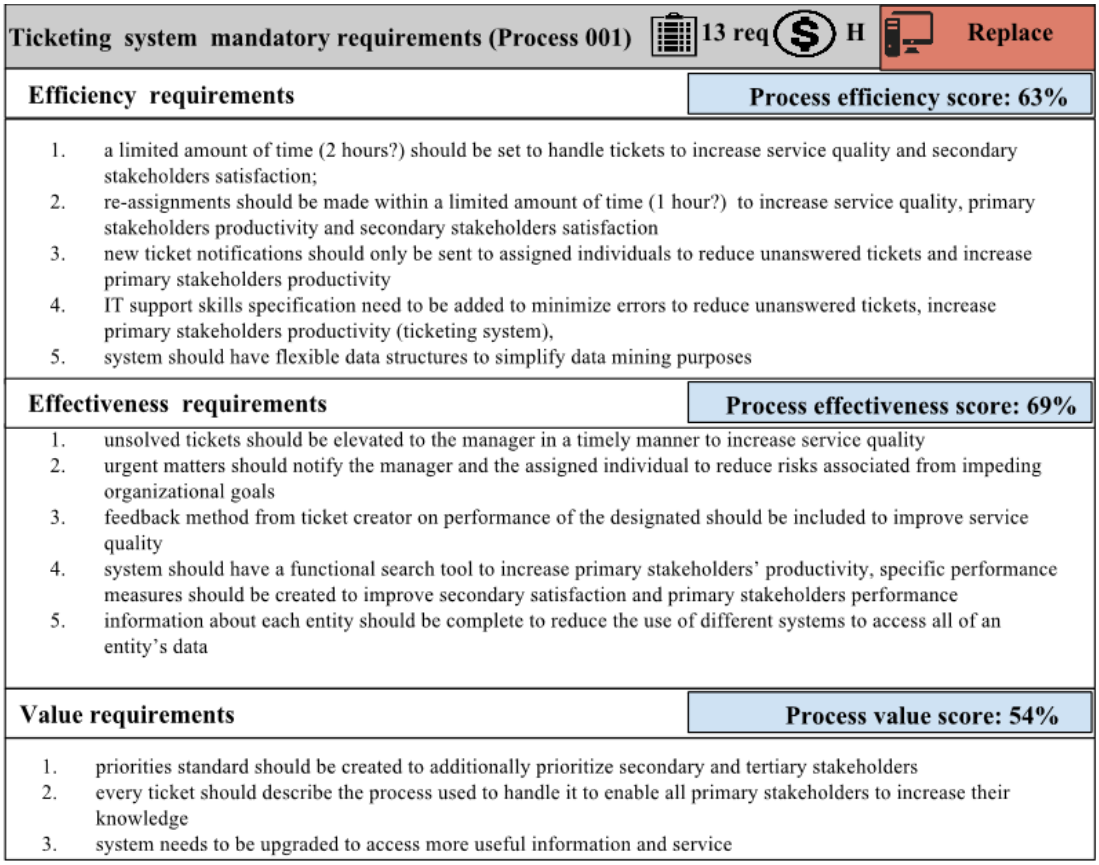

Figure 11: Ticketing system mandatory requirements

5. 5. 3. Feedback about the proposed method by the participants of the case study

The NPO found the results of this case study very useful and eye-opening. During the last interview with the IT Executive Director of the organization, she explained that the results helped clarify the reasons why they were experiencing IT-related issues and negative feedback from executives. She was particularly satisfied that issues with the IT Support activities and the IT training activities were clarified, as the IT team was not able to pinpoint the exact causes for the poor performance feedbacks they received in those two areas. She mentioned that this system had enabled them to see

how they can implement a performance measurement system to track every process' performance. She also realized that she might have to include a direct feedback system to handle those issues more efficiently. She also believes that this approach works, as she was already thinking of addressing IT project and IT database activities' performance by incorporating better CRM and intranet software. She believes that this system has helped the team better understand the requirements for purchasing those software. The IT Executive director further mentioned that implementing a new IT training session for the IT staff may be useful in attaining each process' goals and their efficiency, effectiveness, value and commonality performance. She mentioned that she would take a closer look at the gathered requirements and decide on how to implement changes.

Likewise, the enterprise architect, the IT staff manager, the digital team representative, and finance team representative mentioned that this methodology has helped them see the value of non-functional requirements. Indeed, they mentioned that they had previously tried to address some of their information system issues by gathering requirements from interviews, and they noticed that they had only focused on functional requirements. This process has enabled them to see that implementing a successful IS would need to address multi-dimensional characteristics of IS. On the other hand, the communications representative and the IT specialist were more focused on non-functional requirements, and they stated that this methodology had helped them better identify functional requirements. They also mentioned that some

of the wordings could be difficult for individuals that do not have a technical background. They suggest using a simpler vocabulary. However, the IT staff manager believed that this methodology is too detailed and it may not be able to satisfy all the user requirements as they can change over time. He said that accountable individuals might not be able to dedicate much time to address every detail of a process, so generalizing the scorecards and using user-specific requirements could help offset those limitations.

Chapter 6: Discussion

6. 1. Research findings

The Effective Requirements Engineering Methodology (EREM) approach is designed to facilitate the requirements engineering (RE) process for information system consultants and their clients. Three research questions, which addressed critical information needed for the approach to be effective, guided the methodology. The case study shows a practical application of the approach in a real-world setting.

6. 1. 1. Measuring the performance of information systems

The first question of the research paper asked: "*RQ1: How can a detailed methodology effectively measure an IS performance at the functional level of any organization type*?" To answer that research question, research was conducted on existing literature works that discussed about it. Then, successful performance criteria found in those findings were collected and organized into four dimensions: the efficiency, effectiveness, value, and commonality aspects of an IS process. Hence, an information system's effectiveness can be measured through its multidimensional key performance categories.

According to the results, focusing on the efficiency, effectiveness and value benefits of a technological system does not guarantee that an IS is performing well. The usage or commonality of an IS plays an important role in determining its performance. On

the other hand, the high usage of a system does not necessarily signify that it is performing well. It may be the only system that can achieve a goal at a particular time in an organization. Furthermore, considering different users' perspectives and satisfaction about an IS is quite important. From the results, it seemed that the usage of a system often coincided with the satisfaction and perception of different stakeholders. Also, IS process procedures played a major role in measuring the performance of an IS. Indeed, IS processes that were not efficient, effective, valuable, or common, hindered the performance of a technological system.

6. 1. 2. Key determinants that make requirements engineering effective

The second research question was: "*RQ2: What are the key effective RE determinants that simplify a consultant's understanding of an organization's needs and simplify communication with a client?"* For the RE process to be effective, the EREM considered every RE component. Again, research on existing literature works was conducted. Most studies revealed that RE elicitation, analysis, validation, documentation, and management methods, vary in their applicability to specific projects, organization type, consultant skills or client's preferences. Therefore, a list of the strengths, weaknesses, and trends of RE techniques, as well as IS models, were analyzed to effectively incorporate every effective RE aspect into EREM that addressed those limitations.

The results of this research showed that each of the RE components has specific criteria that is effective. To begin with, the elicitation component of RE can be

achieved using different methods. This thesis found that using a combination of methods to be more effective than relying on just one. For instance, information about the office culture was gathered using information from external sources. However, interviews with the different stakeholders at the NPO proved conflicting perspectives of the office culture. Similarly, selecting the right stakeholders to interview was found to be a key effective RE criteria. Indeed, the upper-level management perspective on the activities' performance of the NPO proved to be quite different from functional level staff members. Hence, capturing different views is important.

The validation component of RE in EREM turned out to be quite useful and effective in gathering requirements. Indeed, the visual diagrams of the processes were effective at spotting errors in their procedures and enabled users to see missing data collected from technological systems. Similarly, the documentation component was instrumental and effective at gathering requirements. The commenting feature, for example, helped keep track of potential requirements and important information for future review. Finally, this research found that the management and analysis effectiveness of RE can only be achieved to the extent of a consultant's understanding of how an organization functions. Adopting an agile IS consulting model turned out to be more effective than other models.

6. 1. 3. Methodology to optimize effectiveness of requirements engineering

The last research question asked "*RQ3: How can a consultant successfully optimize the effectiveness of RE, regardless of his or her experience in IS consulting?"* To

answer this question, a literature research method was also used, as well as the findings from the previous two research questions. While conducting research, one trend was noticeable: most of the proposed solutions presented frameworks or high-level guidelines. On the other hand, the EREM approach attempted to give importance to the IS performance at the functional level of a process, to enable new consultants to have a clear idea on how to effectively gather requirements. Prioritization methods were also recurring solutions to optimize the effectiveness of RE. However, they were mostly focused on prioritizing requirements based on a client's goals of their perceived issues. Since the perceived issues may not actually be the IS problem, a client could prioritize the wrong requirements. The first research question revealed that it is important to consider the multidimensional aspects of a process. Hence, EREM also included multidimensional aspects of a prioritization method based on critical activities, processes, and technologies identified.

The main finding on this research question was the importance of combining key IS performance measures and effective RE determinants to optimize the effectiveness of RE. Addressing both of those findings in a detailed procedure also proved to even more effective. Furthermore, a methodology that does not lead an IS project based on biased information, helped optimize the effectiveness of RE. While it could be tempting for a consultant to follow the client's perceived issues of their IS, the case study proved otherwise. The initial problem statement did not completely coincide with their actual problem. Reducing bias can also be accomplished by minimizing

human error. Using a scoring method to measure the performance of an organization's IS can contribute to reducing the pre-conceived conclusions made from a client or a consultant. Also, providing different analysis results from the gathered information was found to optimize RE. Creating a simple RE methodology is another way of optimizing RE. When each section of EREM's guide was simple enough for an accountable individual to know what was expected of them, they were better at providing information. Hence, a simple, effective RE methodology would not require a consultant to have any expertise in the field and facilitate communication between a consultant and a client.

6. 2. Research contributions

The research contributions of this thesis are multifold. To begin with, this research explored and identified various challenges with requirements engineering (RE) frameworks and methodologies for information system (IS) consulting projects. Three recurring challenges were identified, including the lack of detailed, effective RE methodologies; communication challenges between consultants and their clients; and difficulties for new consultants to perform well in IS projects. While many researchers proposed different approaches to requirements engineering, they did not provide detailed methodologies that are effective. This thesis contributes to providing a new detailed methodology to requirements engineering. Indeed, the four step-procedure focuses on addressing every effective aspect of RE's components including the elicitation, analysis, validation, documentation, and management of requirements. Furthermore, literary works' solutions to communication challenges revolved around

simplifying the type of language used to describe requirements, or models used to represent the client's organization. This thesis' contribution goes further than using simple requirements languages to offset communication challenges, by proposing to use a collaborative system that both consultants and clients can use, at the same time. The proposed approach also simplifies communication by allowing users to view visual representations of their inputs on the same screen. In addition, even though many studies highlight the importance of having an experienced consultant to increase an IS project success, they have not discussed how new consultants can succeed in that field. The proposed approach of this thesis enables consultants, with any work experience, effectively gather requirements.

Second, this paper answered the three research questions that led to the development of the proposed Effective Requirements Engineering Methodology conceptual system. As mentioned above, this research contributes to providing key IS performance measuring methods. It has also identified key RE components' aspects that would lead to the success of an IS project. Also, this thesis contributed in providing a unique, comprehensive methodology to optimize RE. Indeed, the guides and scorecards help generate visual representations and text-based results of the prioritization of elicited requirements based on the IS performance scores, client priorities, and IS costs.

6. 3. Practical implications

The proposed EREM has practical implications. As demonstrated in the case study, using the approach has helped the organization gather and prioritize requirements. It has also enabled the organization to identify critical activities, processes, and technological devices. The feedback from the stakeholders of the case study, not only confirmed that the results were accurate and useful for RE, but also helped the NPO better understand, measure and manage their information system.

Other than the organization in case the study, this approach can also be applied to any organization. The proposed methodology ensures that organizations of any size can use the system. For example, organizations that have many employees will be able to assign accountable individuals for filling out the guides to various individuals, and at the same time the individuals in leadership roles can validate and edit any section of the guides. In contrast, smaller organizations will be able to use the EREM system and competitively leverage their information system by setting maturity goals and assuring that their IS addresses every identified key IS performance criterion. Furthermore, organizations of any size or any industry, whether they provide products or services, would be able to use this system as the key IS performance criteria were identified from proven research studies that addressed various types of industries of different sizes that provide products and services to their customers.

6. 4. Limitations

The proposed methodology was tested at a medium sized non-profit organization, and the results proved to be quite promising. However, this approach breaks down and analyzes every main activity's processes, which can be quite time-consuming for smaller organizations. This is mainly because they are less likely to be able to delegate multiple accountable individuals to fill out the guides, and few employees would have to dedicate most of their time on the system.

Furthermore, since the EREM's approach is based on a conceptual system, the specifications of the system may impact the effectiveness of the approach. Indeed, the system will have to be able to handle various workloads without compromising the content and quality of the results. The system should also be able to enable all its users, including consultants and their client's accountable individuals to collaborate, and edit information in real-time. The latter requirement will ensure that conflicting or repetitive entries are not stored.

Chapter 7: Conclusion

This thesis paper addressed the various challenges information systems (IS) consultants face during the requirements engineering (RE) process by providing an innovative, effective requirement engineering methodology (EREM). The EREM approach provides a conceptual system that follows a four-step methodology that simultaneously elicits, analyzes, documents, validates, and manages requirements of a project. Each step of the methodology included a guide as a standard for consultants to use throughout the process. Visual representations of the entered information by the system users are also included in the methodology. The paper also addressed three research questions that helped guide the design of the methodology. Key information systems performance criteria were identified and used to build scoring instruments. Key requirements engineering components' determinants were also used to build the guides.

Since this thesis discussed the use of a system to implement the EREM approach, future research will intend to further design and build the system. Furthermore, since this thesis conducted one case study to prove the methodology's practical implications, more research may be needed to further test and apply this methodology.

Appendix A

Interview question bank	
Culture	What type of work culture do you promote?
Consulting Project	What do you like to accomplish for the duration of this project? What would you like to exclude from this project? Have you previously gathered requirements for your project? What was the outcome and how were the requirements gathered? What are your perceived issues with your IS? How do you measure the success of the project? Who determines the success factors?
Goals	Tell me about your organization. What are the goals/mission/objectives of the organization? Tell me about your services/products. What is the role of your IS in achieving those goals? How do you achieve those goals?
Stakeholders identification and roles	Who are the stakeholders of your organization? (including internal and external stakeholders) How do their goals and roles differ from each other? Who are the stakeholders who will take part of this project? How do you help the team learn and grow their skills in a process? Are those methods being used? How often? How do you train your employees?
Activity information	What are the main activities or functions of your organization/department? What are their goals? Who is accountable in managing that activity? How is the performance of an activity measured? How do you determine the prioritization of the activities in terms of their importance for the overall success of your organization/department?
Process procedures	How do you produce/provide product/service in Activity X? Can you walk me through process X and state how every technological tool is used during the process? Who is accountable in managing the process? How is the performance of your IS of process X measured? How are urgent matters handled?

Data and Information Collection	What data is stored? What type of data would be useful to have but is missing? What type of data do you wish to have?
Documentation	Does a repository exist? Who has access to it? Who is responsible in maintaining it? How are the different versions tracked? How are the information updated?

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