A Conceptual Model for Assessing the Value of Information Technology

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Abstract

The value of an IT system can be considered from a number of different perspectives. Specifically, the same IT system can be valued differently across different stakeholders, time periods, usage environments, and other contextual factors. When measuring the value of an IT system, it is important to consider what value perspectives are relevant and how those perspectives affect the development of value metrics. An IT value assessment framework is proposed to aid in identifying such contextual factors and exploring how those factors affect the value that is realized from an IT system.

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Chapter 1:

Introduction

1.1 Introduction

Discussing the ***VALUE*** of information technology (IT) has proved to be a very difficult task for academics and practitioners alike. As we will show in the literature review, a number of models have been created for assessing and discussing value but a broad theory or framework does not appear to exist. For example, a framework that can describe many forms of anticipated and realized value, that can assess value in more quantitative terms, and that can help guide the design of IT for value has not appeared in the literature.

To illustrate this gap, first consider taking a picture of a child with a digital camera and how this value could be described. The photographer, as a direct user of the technology, may obtain value from using the camera and its sophisticated functions. The family of the child, as users of the technology's output, may obtain value immediately from the picture. The family may also find value later, in different contexts, as the individual ages, gets married, and eventually passes away. This form of contextual understanding of IT value *in situ* has not been incorporated in any of the models found in the literature. The models may talk about the types of value a user may get but a detailed model or expansion is not provided that captures both *in situ* and temporal aspects.

Second, consider quantifying and actually assessing the existing or potential value. Before a rigorous measurement or assessment of value can be attained, the types of values must be described and understood. If we assume that a description of value is indeed possible, how might the actual value then be analysed? The literature we have reviewed does not provide any systematic or model driven way to think about the assessment of value. By this we mean: what values can be measured, where they may be measured, how they can be measured, and how the measurements might be interpreted. There have been economic assessments and models of value, but there has not been a theoretical basis for extending this to other forms of value.

Third, if it is assumed that i) value is important, and ii) you can possibly describe and assess it, then it might be reasonable to speculate about the ability to consciously design IT for improved or maximum value. For example, how could the user interface and other functions be designed for the best possible efficiency and effectiveness?

Such a theory driven framework supporting the description and categorization of value, the assessment of value, and the design for value does not currently exist. It is not certain if such a framework can exist. However, this is the larger research question and agenda that this thesis is part of. Preliminary ideas for a socio-tech model of IT incorporating temporality and value *in situ* is proposed in McKay (2004). This preliminary model was used as a basis for the value description analysis performed in McKay and Ng (2004). In terms of providing insights into how to decompose value and describe it, the framework appeared to have potential value. The full theory has not been developed and relationships tested, but basic example and existence proofs have indicated that this line of research has potential. The research reported in this thesis is the next step: probing the ability to systematically assess value using a socio-tech approach.

To illustrate the value assessment issues that this work attempts to address, imagine that you want to implement a web portal for cancer patients and you need to justify the expense and effort. What is the value of such an endeavour and how can the value be measured to justify the project? To answer this question, it is necessary to define what constitutes *value*. The value of the patient portal will have different meanings when you consider the perspective of patients, patient family members, physicians, and the hospital. A patient's family members may find value in the portal if it provides care giving information such as side effects to monitor and the patient’s medication schedule. A physician may find value in the portal if it makes their patients more knowledgeable and thus easier to communicate with. Value may also change over time as patients go through their treatment. Information regarding initial side effects relating to cancer therapy may be more useful when a patient starts therapy than near the completion of their therapy. Value can also be influenced by factors specific to an individual. Some patients may not be able or want to use the internet, rendering the portal useless. Because the patient portal may provide value in a number of different situations, each occurring at different time periods, measuring the value of the portal presents a number of a challenges addressed by this research effort. Namely: What forms of value should be measured? What metrics should be used? Where and when should these metrics be deployed? And what do these measurements tell us?

The contribution of this thesis is to operationalize the socio-technical value models proposed by McKay and Ng (2004) by linking them with the business process measurement concepts proposed by Camp (1995). More specifically, the process models described in Camp's (1995) methodology to describe business processes are extended and used to explore the *in situ* and temporal aspects of value proposed by McKay and Ng (2004). Our objective is to explore whether these concepts can be combined to form a socio-technical methodology for systematically assessing the value of an IT system. This thesis does not claim to provide a fully validated methodology, but investigates the merit of certain relationships that can be used to think about value in real situations and provides a base for future research. This thesis is organized as follows:

- Section I: Introduction
- Section II: Literature Review
- Section III: Theory Development
- Section IV: Research Design
- Section V: Case Study
- Section VI: Analysis and Discussion
- Section VII: Conclusion

1.2 Motivation

This socio-technical approach to value implies that the assessment of IT value requires identifying what value means with respect to the interaction between the IT and its organizational context and developing metrics to capture these forms of value. The research questions presented by such a problem context are:

- What is value?

- How can value be measured?

The following sections will discuss these questions in greater detail.

1.2.1 What is Value?

The Oxford English Dictionary defines value as “the relative status of a thing, or the estimate in which it is held, according to its real or supposed worth, usefulness, or importance” (Simpson & Weiner, 1989, p. 416). Extending this definition to IT, IT value should therefore be an estimate of an IT system’s actual worth, usefulness, or importance. Such a definition does not indicate from what perspective worth, usefulness, or importance is established and does not preclude the possibility of multiple perspectives. Shapiro and Varian (1999) provide insight into how this judgment is formed, describing IT as an "experience good," where the true value of the good cannot be revealed until it is used because it is context dependent.

Value is established through a complex relationship between the IT system and the context it used within. There are numerous contextual factors that can affect the value realized from an IT system. Who the user is, how tasks utilize the IT system, and when the IT system is utilized are just a few of many attributes that can influence the value of an IT system. This relationship can be exemplified when we consider what constitutes IT value in different contexts. The following three subsections provide examples of what we mean by contextual value.

1.2.1.1 Consumer Electronics Example

The first example considers the value of IT in a consumer entertainment context. These IT systems include devices such as MP3 players, cameras, and televisions. McKay and Ng (2004) introduce preliminary concepts that suggest a number of contextual factors influence value. Interpreting some of these factors in the context of this thesis illustrates the idea of contextual value:

- **Producer or Consumer**

  The value of a device can be described from producer and buyer perspectives. Consider a device that is used to produce something that a consumer purchases. For example, a personal computer used by an ad firm to create an advertising pamphlet for a small retail firm. The ad firm gets value from using the personal computer. There is also a link to the retail firm (and possibly to its customers) if the pamphlet gives them value - faster creation, easier content inclusion, and so forth. Thus, when the information technology is used in a value chain, there are two perspectives to consider. McKay and Ng (2004) used a digital camera to illustrate the values given to the photographer versus the values given to the receiver(s) of the photographic image.

- **Temporal Dynamics**

  Time also plays a significant role in determining value. The value of the device can increase or decrease over time. This is not a novel concept in itself. For example, the value of a photographic device may increase closer to the holiday shopping season as demand increases and decrease later on in its lifecycle as new revisions of the device are released. However, the meaning of the value obtained through usage can also change over time. For example, consider a parent shooting a home video of their child. The value of the video will have a certain meaning in the immediate timeframe after the video is shot and can have an entirely different meaning decades later when the child has grown up.

- **Utility or Enriched**

  The meaning of value will also be different if a device serves a utilitarian or enriched function. The use of enriched function devices cause users to experience "conscious feelings of pleasure or enjoyment" (McKay and Ng 2004). An example of this is the conscious feeling of satisfaction a user may derive from using highly stylized electronics. Other devices are used without any feeling and are simply seen as tools. Consequently, the meaning of value will be different between these two types of devices.

- **Usage and Results**

  Value can also be derived from the use, operation, and output of the device. For example, consider a high capacity MP3 player. Value can derived from the actual use of the device because the user can listen to substantially more music. Value can be derived from its operation because the MP3 player can hold the user's entire music collection, eliminating the need to transfer music between different music repositories. And finally, the output of the device also provides value, where music can be consumed through a set of headphones on a bus or a set of loudspeakers at a party.

- **Consumer Dependencies**

  The value of a device is also dependent on the individual characteristics of the consumer. It is conceivable that different consumers will derive different levels of value from the same device. For example, a consumer who is experienced with photography may not derive as much value from a fully automatic camera as a beginner who simply wants a picture with minimal effort.

- **Spatial Dependencies**

  The value of a device can also be different depending on the location the device is operated in. For example, the value of an in-car navigation system may be different when it is used in an unfamiliar area from when it is operated in the driver's home city.

- **Co-Dependencies**

  The value of a device can also be influenced by dependencies on other devices. Value can be contingent or modified by these dependencies. For example, the value of a DVD player to a consumer may be affected if a digital surround sound system is used to output the audio signal of the DVD player.

This brief example identifies a number of contextual factors that may influence the value of a consumer electronic. A wide range of contextual factors are considered in this example such as different types of users, different points in time, and different types of usage. The next example follows a similar approach, discussing how contextual factors affect IT value in a healthcare context.

1.2.1.2 Patient Portal Example

The second example introduces the subject of the case study conducted as part of the thesis and considers the value of IT in a healthcare context. More specifically we consider the value of a patient web portal that provides cancer patients with information regarding their treatment. A similar approach taken by McKay and Ng (2004) for preparing the contextual value dimensions for consumer electronics was followed for the cancer portal. The analysis suggests that the value of such a portal system is dependent on a number of different contextual factors which may include:

- **Prognosis of Treatment**

  Since the portal is a tool used in the cancer treatment process, how a patient physiologically responds to their cancer treatment overall can influence the value they derive from the patient portal. For example, the value of accessing treatment information online may be different for a patient who has a high potential of recovery compared to a patient who is in palliative care (no longer being treated for recovery).

- **Position in Treatment**

  Where a patient is in their treatment may also have a large bearing on the value of the portal. The portal provides treatment information such as the procedures to be performed, possible treatment side effects, appropriate medication, symptoms to look for, etc. The value of being able to access this information through a portal may have different value to new patients unfamiliar with the treatment process than patients that are already familiar with the treatment process.

- **Patient Engagement**

  The degree to which patients are engaged in their treatment can imply a different meaning of value for the portal. For example, patients who proactively research their cancer therapy on a regular basis through the portal, may value the portal as a constant guide throughout their treatment. More passive patients that only use the portal in extenuating circumstances may value the portal differently as a backup resource for extenuating circumstances.

- **Trust in Portal**

  Value can also be affected by the patient's attitude towards the patient portal. In some cases, patients may have preconceived notions regarding the usefulness of the system. For example, the value derived from the portal may be different if a patient has an enthusiastic attitude toward the function and information provided by the portal compared to a patient who views the system with indifference, fear, or mistrust.

- **Operation of Portal**

  The value derived from the portal may also depend on its operation. This includes both execution and quality aspects. For example, the value a patient derives from the portal can be influenced by the depth and clarity of treatment information available and can also be influenced by the availability and responsiveness of the site.

- **Use and Support by Care Givers**

  Value may also be influenced by the degree to which the portal is integrated into the treatment process. The value provided by the portal may be different if it is a standalone system provided by the hospital than an integrated system where physicians refer patients to the system as part of their standard practice.

- **Use and Support by Care Receiver**

  The amount of time patients spend using the portal may also be a major determinant of value. The value a patient derives from using the portal on a regular basis may be different from the value a patient derives from using the system occasionally.

- **Timing of Information Access and Use**

  Value may also be significantly affected by the timing of portal usage. Patients that are made aware of treatment details through the portal prior to treatment may have a different experience from patients who attend treatment totally uninformed. Consequently, this can alter the value of the portal to both patients and clinical staff.

- **Use by Support Group**

  The portal also has the potential to provide value for a patient's support group. Since support group members may not be present for consultations, the portal enables members of the support group to access the patient's treatment information later on. This aids them in providing appropriate care to the patient, such as reminding the patient not to eat prior to an examination.

In this case, a completely different set of contextual factors are suggested to affect the value of an IT system. It is interesting to note similarities between the contextual factors between this and the previous example. For example, both sets of contextual factors identify different points in time and different stakeholders. The next example considers the value of an IT system in a retail context.

1.2.1.3 Barcode System Example

The previous two examples illustrated the idea of contextual value in consumer electronics and a web service context. The idea of contextual value assessment is applicable to other domains as well. For example, this subsection considers IT value in a retail context. Specifically, we focus on a barcode system used to input product prices at a checkout stand. Again, using the McKay and Ng (2004) methodology, we identify some of the contextual factors that may affect the value of such a system:

- **Direct and Indirect Operators**

  Different perspectives of value can be found between direct and indirect operators. Direct operators are those that interact with the system directly, such as a cashier that scans the barcode from items. Value is derived from replacing the manual process of reading and entering price information with a simpler process of applying the barcode scanner to the product. Indirect operators are those whose tasks are indirectly affected by the barcode system. An example of this is a grocery store clerk who must bag the items that are rung through by the cashier. Value is derived from how tasks are indirectly impacted by the barcode system. In the case of the clerk, the derived value may be the increased workload due to the barcode scanner increasing the cashier's throughput.

- **Employees and Employee Unions**

  Different value perspectives can also be found between employees individually and employees as a whole. For example, an employee may derive value from a barcode system because the barcode scanner allows them to perform their job more efficiently and reduces manual labour. An employee union may derive value from the barcode system differently based on fewer injury claims due to less manual labour or increased job losses due to efficiency gains enabled by the barcode system.

- **Owners and Customers**

  The value of a barcode system can also be described from owner and customer perspectives. An owner may define value as how the barcode system contributes to the organization's goals. For example, does the barcode system increase sales or reduce labour costs? Customers derive a different form of value from the barcode system, such as its impact on their wait in checkout lines or the accuracy of price calculations at checkouts.

- **Manufacturer**

  The value of a barcode system can also be interpreted from the manufacturer who is responsible for placing barcodes on their product. While the barcode may only be a standardized code to print on the product label, the barcode itself can be tremendously valuable if it conforms to packaging requirements required by retailers to carry a product.

- **Database**

  Barcode systems require a database backend that can associate barcodes with product information. The backend that supports the barcode system also plays a significant role in determining the value of the system. For example, consider a barcode system with a database that houses hundreds of thousands of items. The sheer magnitude of data and resources required to create and maintain such a database may influence the value of the barcode system as a whole.

- **Physical Attributes**

  The value of a barcode system can also depend on the items that it processes. Certain physical attributes can make an item ideal or problematic for managing through a barcode system. For example, items packed in boxes are ideal for barcode systems because barcodes can be printed directly on the box. Small items such as small candies are not as suitable because there is insufficient surface area on a single item for a barcode. Consequently, value can be influenced by the number of items that can be used with the barcode system.

- **Customer Load**

  The value of a barcode system is also influenced by the load of the task it is being used in. For example, consider the difference between a large supermarket and a small local store. The value of a barcode scanner to a large supermarket with a large product inventory and long line-ups during peak hours may be different from the value of a barcode scanner to a small local store that has a much smaller product inventory and shorter line-ups at the cashier.

- **Additional operations**

  Value may also influenced by the additional functionality enabled by a barcode system. For example, consider the analysis of purchasing trends in a grocery store. While it is possible to track purchases through a manual checkout process, this places an additional burden on the cashier that may add an unacceptable level of inconvenience to the customer. Because a barcode system is electronic, additional operations such as tracking purchases can be programmed directly in the database so that purchases are tracked the moment they are scanned. Consequently, the barcode system provides value by enabling new functionally that was not possible with a manual checkout.

In a similar fashion to the previous examples, this subsection identifies a number of contextual factors that may influence IT value in a retail context. Again, it is important to note the commonalities between the contextual factors in all three examples. Contextual factors that involve dependencies and different stakeholders can be found throughout all three examples. The next subsection discusses these commonalities.

1.2.1.4 Value Dimensions

While the previous examples are incomplete, they illustrate how the value of an IT system can vary across a wide variety of characteristics. It is important to note that the characteristics from different examples address similar aspects of IT usage. For example, the “temporal dynamics” characteristic from the consumer electronic example and the “position in treatment” characteristic from the healthcare example both address the time aspect of IT usage. Similar commonalities can be seen between other characteristics as well. Using these commonalities as a starting point, we can group the discussed characteristics into six broad areas:

1. Time
2. Stakeholders / Aggregate Stakeholders
3. Individual Characteristics
4. Task Impacts / Aggregate Task Impacts
5. External Dependencies
6. Usage

1. The time characteristic addresses how the passage of time affects the realization of value from an IT system. The meaning of value can change over time, as illustrated in

the consumer electronics example where the value of a parent's home video changes as their child grows up. Value can also change according to the stage of a particular process, as illustrated in the healthcare example where a patient's position in treatment can affect the value of a patient portal.

2. The stakeholder / aggregate stakeholder characteristic addresses how the goals of different stakeholders and stakeholder groups can influence IT value. Value is derived from the IT system because it aids the attainment of stakeholder goals. For example, a barcode system that eliminates the need for cashiers to manually key in prices may provide value to a cashier because it reduces strain on their hands. Stakeholder groups may have different goals from an individual within that group, leading to different IT valuations. From the cashier example, a group of cashiers, or employee union, may value the barcode system differently from a single cashier because a barcode system may reduce the overall need for cashiers across the retail industry.

3. The individual traits characteristic addresses how the characteristics of an individual may influence how they value an IT system. Knowledge level is one such characteristic that can affect how someone may value an IT system. For example, an novice photographer may derive different value from a fully automatic camera than a expert photographer because the novice depends on the camera to select the appropriate shooting parameters. Individual perceptions and preconceived notions can also affect how someone values an IT system. From the healthcare context, an example of this is how a patient that regards a patient portal with fear and mistrust may derive different value from the patient portal than a patient who approaches the system with an open and enthusiastic attitude.

4. The task / aggregate task characteristic addresses how task level impacts affect the value of an IT system. The introduction of an IT system can change how certain tasks are performed, such as how a barcode scanner changes how cashiers enter pricing information at a checkout. Task impacts can also cascade, affecting adjacent tasks. For example, by utilizing a bar code scanner, a person bagging groceries who may need to work faster due to the cashier's increased processing speed.

5. The external dependencies characteristic addresses how value can be affected by external factors such as inputs and other systems. From the retail example, an example of inputs affecting IT value is how the physical characteristics of the items sold by a store affect the usefulness of a barcode system. Some items do not provide sufficient surface area for a barcode or do not have a sufficiently flat surface to accommodate barcode scanning. The value of an IT system can also be dependant on other IT systems. From the consumer electronics example, this is illustrated in how the value of a DVD player can be influenced by the presence of a surround sound system to utilize the audio signal from the DVD player.

6. The usage characteristic addresses how value can be affected by the manner in which the IT is used. The degree to which an IT system is embraced by an organization or integrated into the tasks performed by an organization, may affect the value that is derived from the IT system. From the healthcare example, an example of this is how the value of a patient portal may depend on the degree to which clinicians refer and encourage patients to use the portal to support their treatment regiment.

Moving forward, we will refer to these six dimensions as the preliminary dimensions of IT value. While other value dimensions may exist, the six provide a reasonable starting point to approach the complex nature of IT value. We can classify the contextual factors presented in the previous three examples into the preliminary IT value dimensions, as illustrated in Table 1.

Table 1. Potential Value Dimensions

	Consumer Electronics	Health Care (Patient Portal)	Retail (Barcode System)
Time	Temporal Dynamics	Position in Treatment Timing of information Access and Use	
Stakeholders/ Aggregate Stakeholders	Producer or Customer	Support Group	Employee and Employee Unions Owners and Customers Producers
Individual Characteristics	Utility or Enriched Consumer Dependency	Patient Engagement Trust in Portal	
Task/Aggregate Task Impacts	Usage and Results	Prognosis of Treatment Operation of Portal	Direct and Indirect Operators Customer Load Additional Operations
External Dependencies	Spatial Dependencies Co-Dependencies		Database Physical Attributes
Usage		Usage and Support by Care Givers Use and Support by Care Receivers	

When we talk about the value of an IT system, we can get a better idea of what we are talking about by drawing from the preliminary IT value dimensions to ask questions such as:

- At what point in time is value being considered?
- From whose perspective is value being considered?
- From what demographic is value being considered?
- From what scope of activities is value being considered?
- From what types of deployments is value being considered?
- From what types of usage patterns is value being considered?

These questions dichotomize IT value, where different combinations of answers to these questions identify different types of value. For example, the type of value provided by a patient portal to a senior citizen well into their cancer therapy process may be different from the value provided to a young adult just entering their cancer therapy process.

The multi-dimensional nature of IT value presented through these examples presents a major challenge for assessing IT value. Because different types of IT value can exist, an IT value assessment must account for these forms of value, requiring the assessor to be sensitive to different IT value dimensions. Part of this thesis addresses how assessing IT value can be sensitive to such dimensions.

1.2.2 How is Value Measured?

In addition to specifying the type of value being investigated, assessing IT value requires the development of metrics to investigate value. The development of metrics is not a trivial task. To develop a metric to investigate a particular form of value, some questions that need to be considered are:

1. What phenomena should be measured?
2. Where should measurement occur?
3. When should measurement occur?
4. How should measurements be interpreted?

The first question addresses what the metric should be measuring. To investigate a particular type of value, there are numerous phenomena that can be measured. For example, assuming that information quality is a type of IT value, what constitutes quality information? High quality information may be a unique piece of information that managers need or greater accuracy in an existing piece of information.

The second question addresses where a metric should be deployed. For example, consider a survey metric that measures a patient's comprehension of the medical process. Patient comprehension of the medical process can be measured in a variety of processes, such as during a consultation, when they are undergoing a test, or when they are at home taking their medication.

The third question addresses the time at which a measurement should occur. Metrics can be deployed prior to the realization of value, while value is being realized, or after the value has been realized. Again, consider a survey metric that measures patient comprehension. Such a metric can be used to follow each consultation with a physician or it can be used later, when the patient has completed a series of treatments.

The last question addresses how the results obtained by a metric should be interpreted. For example, suppose that system usage logs are used to investigate the usefulness of a patient portal to patients. What insight into usefulness is revealed if 30% of patients log on to the system five or more times per week, 40% patients log onto the system four to zero times per week, and the remaining 30% of patients do not use the system at all?

These questions identify a number of issues that may need to be dealt with in the development of metrics. To investigate a particular aspect of value, assessors may need to decide what phenomenon should be measured, where measurements should occur, when measurements should occur, and how measurements should be interpreted. On what basis should these decisions be made on? Why should one phenomenon be measured instead of another? Why should measurement occur at this task instead of another? A portion of this thesis investigates how these questions can be addressed.

1.3 Summary

This section introduced the assessment of IT value as the problem context for this thesis. Based on a socio-technical perspective, two major research questions regarding this problem context are proposed:

1. What is value?
2. How is value measured?

Based on the examples and discussions, a number of issues regarding value and the measurement of value are identified and will be the focus of this study. Based on the previous examples and discussions, it is apparent that IT value can be a complex entity that is influenced by numerous contextual factors. Some of these factors may be: time, stakeholders, individual characteristics, task impacts, external dependencies, and usage. When assessing IT value, it is necessary to consider how these dimensions should be addressed. Additionally, the development of metrics to capture value can entail a number of issues. Some of these issues may be: what phenomena to measure, where measurement should occur, when measurement should occur, and how measurements should be interpreted. This thesis will propose an initial framework to address these questions and will partially validate this framework through a case study.

Chapter 2:

Literature Review

The previous chapter introduced the problem context of assessing IT value, discussing the possible dimensions of IT value and issues of metric design. This section examines how these topics have been addressed by the literature.

Section 2.1 will examine how the literature addresses the different dimensions of IT value. To review this field, we partition our analysis into three parts. The first part discusses IT acquisition frameworks that propose factors and processes that drive the adoption of an IT system. The second part discusses post implementation frameworks that identify different categories of impacts that result from adopting an IT system. The third part discusses a model of IT value that proposes multiple dimensions of IT value. The purpose of this review is to determine how or if these bodies of literature address the dimensions of IT value suggested in the previous chapter.

Section 2.2 will examine the literature regarding the design of metrics. In particular, we will examine how the literature addresses metric design issues, such as what to measure, where to measure, when to measure, and how measures should be interpreted. Based on the metric design principles identified through this review, the applicability of these principles to assess IT value will be discussed.

2.1 Review of IT Value Dimensions

The discussion regarding IT value in the previous chapter suggests that IT value is a broad concept that describes an IT system's actual worth, usefulness, or importance. It is broad because value can have many dimensions, some of which may include: time, stakeholders, individual characteristics, task impacts, external dependencies, and usage. For example, using a stakeholder dimension, we can consider the value of an IT system to a customer, an operator, or a shareholder of an organization. Based on a time dimension, we can consider the value of an IT system at different points in time, such as before a medical treatment, during a medical treatment, and after treatment is completed. Through part of this review, we aim to investigate what dimensions of value are addressed by the literature. We will examine selections from the following bodies of literature:

1. Acquisition frameworks
2. Post-implementation frameworks
3. IT value frameworks

Section 2.1.1 will review acquisition frameworks and post-implementation frameworks and examine how these frameworks identify different dimensions of IT value. Section 2.1.2 will examine a framework for IT value and compare the IT value dimensions explicitly proposed by this framework to the IT value dimensions implied by acquisition and post-implementation frameworks.

2.1.1 Acquisition and Post-implementation Frameworks

This section analyzes the dimensions of IT value implied by acquisition and post-implementation frameworks. Acquisition frameworks describe the factors and processes that drive IT system adoption. Part of this analysis will examine the IT value dimensions revealed by drivers of the adoption process. Post-implementation frameworks categorize the different types of impacts that can result from the adoption of an IT system. The other part of this analysis will examine the IT value dimensions revealed by the different types of impacts proposed by post-implementation frameworks.

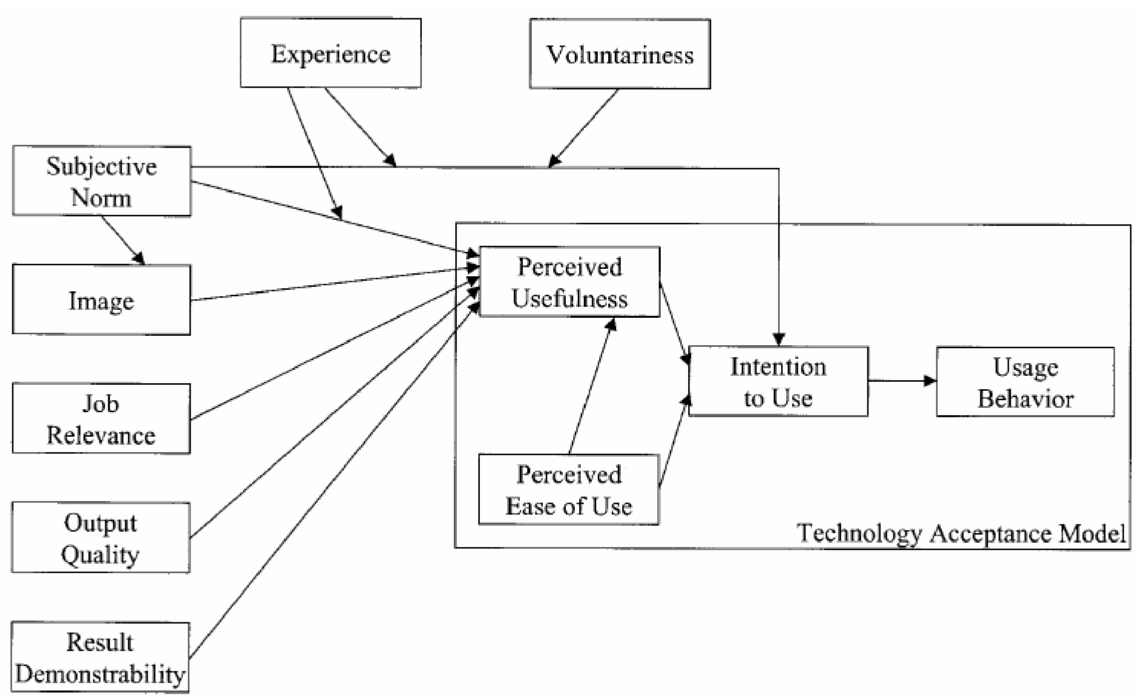
2.1.1.1 Acquisition Frameworks

A number of factors and processes determine how an IT system is utilized within an organization. Perceptions, learning curves, and migration costs are just some of the factors that affect IT system adoption. Here, we review two major frameworks that address the adoption process: the technology acceptance model (Davis, 1989; Davis et al., 1989) and the diffusion of innovations model (Rogers, 1995).

Technology Acceptance Model (TAM)

The technology acceptance model (Davis, 1989; Davis et al., 1989) is a theoretical model that describes how users come to accept and use technology. The theory proposes that an individual's intention to use an IT system is dependent on two factors: perceived usefulness and perceived ease of use. This model is further extended by the TAM2 model (Davis & Venkatesh, 2000) that introduces a number of determinants for the perceived usefulness construct. These determinants are: subjective norms, experience, voluntariness, image, job relevance, output quality, and result demonstrability. Figure 1 from Davis and Venkatesh (2000) illustrates the constructs and relations proposed by the TAM and TAM2 models.

Figure 1. TAM2 Model



(Davis & Venkatesh, 2000)

The original TAM model proposed that perceived usefulness and perceived ease determines were key factors that affect a user's acceptance of technology. Perceived usefulness can be defined as the degree to which a user believes that the IT system will improve their job performance. Perceived ease of use can be defined as the degree to which a user believes that using the IT system will not require additional effort above what was originally necessary. In the TAM model, Davis (1989) proposes that perceived ease of use influences perceived usefulness and both constructs influence a user's intention to use an IT system, which, in turn, affects the user's actual usage of the IT system.

The TAM2 model extends the original TAM model by introducing a number of social and cognitive determinants of perceived usefulness. The social determinants are: subjective norms, voluntariness, and image. Subjective norms can be defined as the degree to which a user believes that social entities important to the user feel that the user should take a particular course of action. Voluntariness reflects whether usage is mandated or voluntary and image reflects whether usage is perceived to enhance the social perception of the user. Davis and Vanketesh (2000) propose that voluntariness moderates the effect of subjective norms on a user's intention to use an IT system. That is, subjective norms will positively affect usage intentions when usage is mandatory and will not affect usage intentions significantly when usage is voluntary. Additionally, subjective norms are proposed to have a positive influence on the perceived usefulness of an IT system. The framework considers the impact of a user's experience on these relationships, proposing that increased exposure to an IT system reduces the influence of subjective norms on perceived usefulness and usage intentions. Lastly, the framework proposes that subjective norms will have a positive effect on image, which, in turn, will have a positive effect on the user's perceived usefulness of an IT system.

The TAM2 model also introduces a number of cognitive determinants that positively influence the perceived usefulness of an IT system. These determinants are: job relevance, output quality, and, result demonstrability. Job relevance is defined as a user's judgement of how applicable an IT system is to their job function. For the task areas where an IT system is applicable, output quality reflects the user's judgement of how effectively an IT system performs or contributes to those tasks. Result demonstrability describes the tangibility of an IT system's performance or contribution.

The constructs proposed in the TAM and TAM2 models address two of the preliminary IT value dimensions introduced in the previous chapter: task level impacts and individual characteristics. The perceived ease of use construct addresses the task level impacts dimension because it describes the additional task overhead that will result from using an IT system. Additionally, the determinants of perceived usefulness (job relevance, output quality, and result demonstrability) also address the task level impacts dimension. Job relevance describes the applicability of an IT system to the tasks being considered; output quality describes the effectiveness of task impacts caused by an IT system; result demonstrability describes the tangibility of the task impacts caused by an IT system.

The remaining constructs proposed by the TAM and TAM2 models identify various individual characteristics that affect the realization of IT value. The subjective norms and image constructs illustrate how an individual’s response to social forces can affect the realization of value from an IT system. Additionally, the experience construct illustrates how an individual’s experience with an IT system can also affect the realization of IT value.

In summary, the TAM and TAM2 models directly address two of the preliminary IT value dimensions proposed in Chapter 1. Task level impacts and individual characteristics are heavily emphasized while other dimensions, such as different stakeholders are largely ignored. Next we consider how another acquisition framework, the diffusion of innovation model, addresses these dimensions of IT value.

Diffusion of Innovations

The diffusion of innovation model (Rogers, 1995) is another theoretical model of IT acquisition. Unlike the TAM model that focuses on how a particular individual or organization adopts an IT system, the diffusion model takes a sociological perspective, modeling how IT is adopted across an entire population. Rogers (1995) defines diffusion as the "process by which an innovation is communicated through certain channels over a period of time among the members of a social system." Based on this definition, the framework proposes four major constructs of the diffusion process:

1. The innovation
2. Communication channels
3. Time
4. The social system

The innovation construct addresses the basic characteristics of an IT system that will influence its diffusion process. These characteristics are: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage is defined as the degree to which the information system is perceived as superior to the previous solution it replaces. The diffusion model proposes that as the relative advantage of an IT system increases, its rate of diffusion will also increase. Compatibility is the perception of how consistent an IT system is with existing values, past experiences, and needs of potential adopters. Greater compatibility also has a positive influence on the rate of diffusion. Complexity is defined as the perceived degree of difficulty involved in understanding and using an IT system, similar to the perceived ease of use construct from the TAM model. Complexity is proposed to have a negative influence on the diffusion rate of an IT system. Trialability can be defined as the degree to which the user can experiment with an IT system before adoption, while observability can be defined as the tangibility of results and contributions from an IT system. Both trialability and observability are proposed to have a positive influence on the diffusion rate of an IT system.

The second construct, communication channels, are the means by which the knowledge of an IT system spreads across a population. Here, the framework identifies two types of channels: mass media and interpersonal. Mass media channels distribute knowledge of an IT system across large audiences, through news reports, advertising campaigns, print media, websites, etc. How radical an IT system is from its predecessors, the controversy caused by using an IT system, and the initiators of the IT system are some of the factors that trigger diffusion through mass media channels. Interpersonal channels distribute knowledge of an IT at a personal level, such as a recommendation from a peer. Rogers (1995) notes that mass media channels are effective in spreading knowledge of an IT system while interpersonal channels are effective for forming and changing attitudes towards an IT system.

The time construct addresses how adoption occurs over time and provides both an individual level and social level perspective. At the user level, the framework proposes a multi-stage model of user adoption that consists of the user acquiring knowledge of an IT system through communication channels, being persuaded to adopt the IT system through interpersonal channels and perceptions of the IT system, symbolically adopting the IT system due to persuasion or social pressures, actually adopting or implementing the IT system into their activities, and seeking confirmation regarding their choice to adopt the IT system. At the social level, the framework proposes that over the lifecycle of an IT system, the total adoption of an IT system over time can be modelled as an S-curve that can be segmented into innovator, early adopter, early majority, late majority, and laggard groups that account for 2.5%, 13.5%, 34%, 34%, and 16% of adopters, respectively.

The social construct encompasses the mechanisms within a social system that facilitate the diffusion and adoption of an IT system. These mechanisms are: social status, social norms, opinion leaders, and change agents. Social status and norms are social forces that can both impede or accelerate the diffusion rate of an IT system. Opinion leaders are influential individuals within a social system whose perceptions of an IT system can affect its rate of diffusion. Change agents also seek to influence the public perceptions of an IT system, promoting the perception put forth by the change agency they are affiliated with.

The diffusion model is a descriptive model of how an IT system spreads across an entire population, illustrating how different social forces affect IT system adoption. The diffusion model addresses three of the preliminary IT value dimensions identified in Chapter 1: time, task level impacts and individual characteristics. The impact of time on IT value is implied through the individual and social models of adoption that occur over time. The task level impact dimension is addressed through the relative advantage, trialability, and observability constructs of the model. Most significantly, the diffusion model provides a richer understanding of how social forces (interpersonal and mass media communications) and compatibility affect how individuals derive value from an IT system.

In summary, the IT acquisition models reviewed in this section address only three of the preliminary IT value dimensions proposed in Chapter 1. The following section examines the dimensions of IT value addressed by post-implementation frameworks and how they compare to the preliminary IT value dimensions.

2.1.1.2 Post-implementation Frameworks

Once an IT system is acquired, it can affect the acquirer in numerous ways. For a commercial organization, work processes, production goals, organizational strategies, company culture, and external organizations are just a few of many things that can be impacted by an IT system. Post-implementation frameworks provide taxonomies to organize such impacts. The purpose of these frameworks is to capture the different contributions of IT systems, providing a starting point by which "the information system function can be evaluated and refined" (Grover et al., 1996). The IS success model (DeLone & McLean, 1992), six classes of IS effectiveness (Grover et al., 1996), and IS effectiveness framework (Seddon et al. 1999) are three such frameworks.

Information System (IS) Success Model

The IS success model proposed by DeLone and McLean (1992) identifies six different aspects of IT impact. Based on an IT adoption model that consists of six interrelated processes, the authors propose six types of impacts to reflect each of the six processes. These six processes are:

1. System quality
2. Information quality

3. Usage

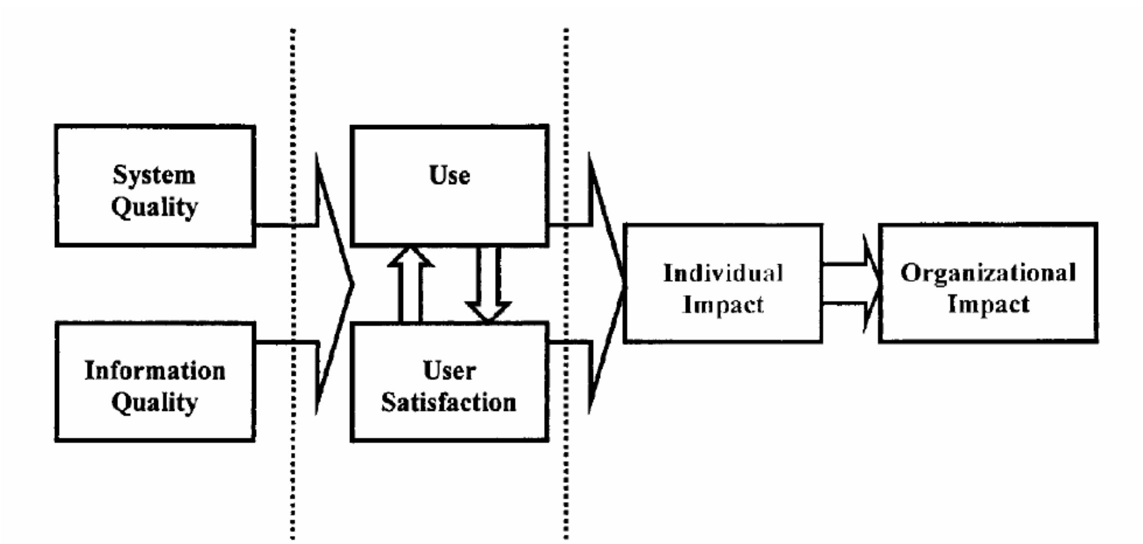
4. User satisfaction

5. Individual impact

6. Organizational impact

Figure 2 from DeLone and McLean (1992) shows the IT adoption model that forms the basis of this framework and illustrates the relationships between each of the processes.

Figure 2. DeLone and McLean IS Success Model



(DeLone and McLean, 1992)

The first two processes in the model address the technical and semantic attributes of the IT system under analysis. The system quality process entails technical attributes regarding the operation of the IT system. More specifically, it is based on the accuracy and efficiency of communication from the field of information theory (Shannon & Weaver, 1949). An example of a technical level attribute would be the amount of time that an IT system is running, or also known as system availability.

The information quality process entails the semantic attributes regarding the information provided by the IT system. More specifically, it is based on the information influence theory of Mason (1978) that recognizes that information being communicated carries intended meanings. Information quality attributes revolve around how efficiently information is being conveyed, such as how easily a user can understand the information they are receiving from the IS.

The remaining four processes are influenced by the system quality and information quality processes, reflecting the effects of the IT system. The first two processes are the usage and user satisfaction processes which describe how the system is used and how satisfied user are with the IT system. The authors propose that usage and user satisfaction are interrelated and are influenced by system and information quality.

The last two processes are individual and organizational impacts. The authors propose that individuals are impacted based on their use and satisfaction with an IT system. Individual impacts, in turn, determine the impact of the IT system on an organization as a whole.

A taxonomy for IT value measures is proposed based on these six processes. In such a taxonomy, measures are categorized by which of the six process areas they measure. The authors propose that such a dichotomy provides a starting point from which metrics to assess IT value can be developed. The actual metrics are not prescribed as they should reflect objectives and context of the value assessment. Table 2 interprets an example by DeLone and McLean (1996) that applies the framework to an e-commerce system.

Table 2. E-Commerce Success Measures

E-Commerce Success Measures					
Systems Quality	**Information Quality**	**Use**	**User Satisfaction**	**Individual Impact**	**Organizational Impact**
- Adaptability - Availability - Reliability - Response time - Usability	- Completeness - Ease of understanding - Personalization - Relevance - Security	- Nature of use - Navigation patterns - Number of site visits - Number of transactions executed	- Repeat purchases - Repeat visits - User surveys	- Reduced search costs - Time Savings	- Cost savings - Expanded markets - Incremental additional sales

(DeLone & McLean, 1992)

To validate the IS Success Model, DeLone and McLean (1992) reviewed the literature between 1981 and 1987, classifying relevant IT value measures into their framework. Overall, the IS Success framework appears to have been well received by researchers with citations in 285 refereed papers from journals and conferences since 2002 (DeLone & McLean, 2003). Two research studies have empirically tested the relationships proposed in the adoption model (Seddon & Kiew, 1994; Rai et al., 2002) and 14 other studies have investigated some of the explicit and implicit relationships proposed by the framework (DeLone & McLean, 2003).

The IS success model proposes characteristics that fall into four of the preliminary IT value dimensions: tasks level impacts, usage, individual characteristics, and stakeholders. The system quality and information quality constructs address the task level impacts dimension, recognizing how an IT system affects tasks at technical and semantic levels. The use construct addresses the usage dimension of IT value, recognizing that IT systems can be used in different ways. The user satisfaction construct addresses the individual characteristics dimension of IT value, recognizing an individual's degree of gratification with an IT system. Lastly, the individual and organization impact constructs address the stakeholder dimension of IT value, identifying two different parties (individuals and organizations) who are affected by an IT system. In summary, the IS success model identifies attributes in four of the preliminary IT value dimensions, overlooking the time and external dependencies dimensions. Next, we consider the IT value dimensions addressed by another post-implementation framework.

Six Measures of IS Effectiveness

Similar to the categorization scheme proposed by DeLone and McLean (1992), Grover et al. (1996) proposes six different categories of IT value measures based on three contextual factors of an IT value assessment: evaluative referent, unit of analysis, and evaluation type.

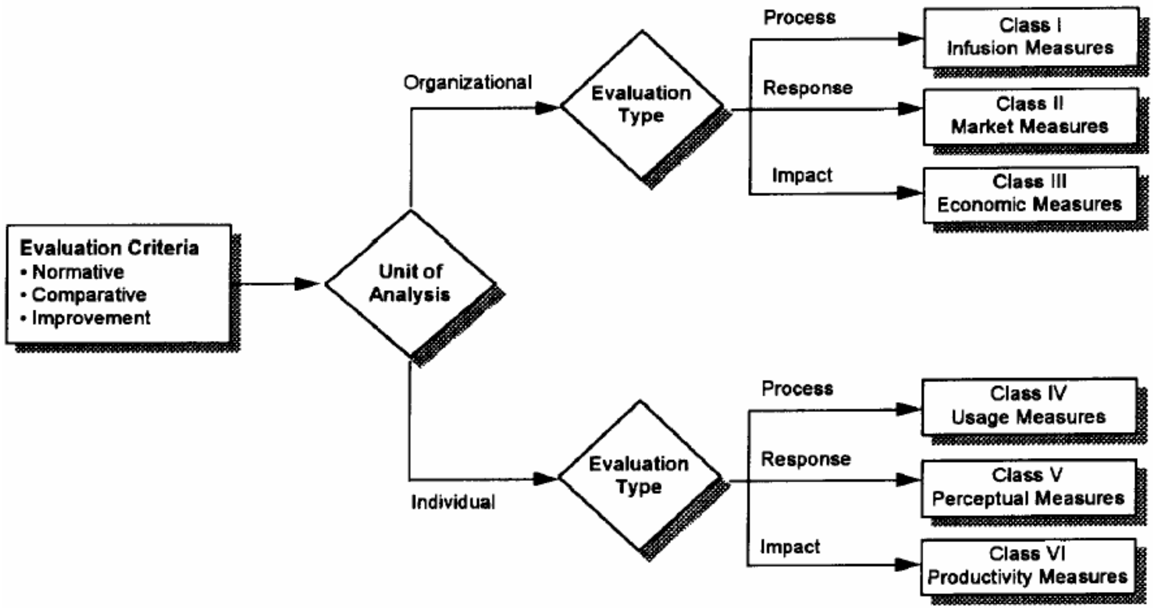
Evaluative referent is defined as the "the relative standard that is used as a basis for assessing performance" (Grover et al, 1996, p. 180). Or more simply, it identifies what the assessment subject is being compared to. Three relative standards for IT systems are introduced: other systems, theoretical ideal, and itself. For assessments where other systems are the relative standard, metrics are used to examine the value of an IT system relative to another system. In cases where a theoretical ideal is the relative standard, metrics are used to examine IT value from an efficiency perspective. For cases where the system at a previous time period is the relative standard, metrics provide insight into how system performance changes over time.

Unit of analysis establishes the organizational level at which value is being measured. For this contextual factor, the framework identifies two levels where measurement can occur: the organizational level and the individual level. Grover (1996) argues that different levels of analysis are necessary because IT impacts at the individual level and organizational level are sufficiently different to require different metrics. For example, an individual level metric may analyze the impact of an IT system on the average length of a physician consultation while an organizational level metric may analyze the impact of an IT system on a hospital's annual operating budget.

Evaluation type identifies which aspect of IT usage is being measured. Here, the framework identifies three aspects of IT usage: process, response, and impact. These aspects can be interpreted as how an IT system is being used, the reaction to IT system usage, and the implications of IT system usage, respectively.

The framework identifies six different classes of IT value measures based on different combinations of the unit of analysis and evaluation type attributes. This is illustrated as a decision tree in figure 3 from Grover et al. (1996).

Figure 3. Six Measures of IS Effectiveness



(Grover et al., 1996)

The six resulting classes of IT value measures are:

- Class I: Infusion Measures (Organizational level, Process Measure)
- Class II: Market Measures (Organizational level, Response Measure)
- Class III: Economic Measures (Organizational level, Impact Measure)
- Class IV: Usage Measures (Individual level, Process Measure)
- Class V: Perceptual Measures (Individual level, Response Measure)
- Class VI: Productivity Measures (Individual level, Impact Measure)

The first three classes of measures are organizational level measures. Infusion measures capture the degree to which the IT system is embraced by the organization. Market measures describe the manner in which internal and external customers react to IT system adoption. Economic measures capture the effects of the IT system on the organization, including areas such as financial performance, competitive position, and overall productivity. The last three classes of measures address the individual level. Usage measures capture the degree to which the IT system is utilized by its users. Perceptual measures describe user beliefs and attitudes toward the system. Productivity measures capture how the IT system affects the performance of different parts of the organization.

To validate their framework, Grover et al. (1996) reviewed a selection of IS effectiveness literature, classifying relevant IT value measures into their framework. The authors reviewed the literature of eight publications between 1980 and 1994: Communications of the ACM, Decision Sciences, Information and Management, Information Systems Research, ICIS Proceedings, Journal of MIS, MIS Quarterly and Management Science. All articles were examined by each author to determine the evaluative referent, level of analysis, and evaluation type, and resulted in a consistency rate of approximately 90% between different authors. The proposed framework is also largely consistent with the IS Success framework (DeLone & McLean, 1992), where all but one class of measures (market measures) proposed by Grover et al. (1996) can be classified into one of the six processes of IT adoption proposed by DeLone and McLean (1992). Infusion and economic measures map to organizational impacts, usage measures map to system use, perceptual measures map to user satisfaction, and productivity measures map to individual impact. In essence, the six classes of IT value measures proposed by Grover et al. (1996) largely serve to refine the ideas of DeLone and McLean (1992), further structuring the construct space of IT value measures.

This framework addresses two of the preliminary IT value dimensions introduced in Chapter 1: task level impacts and stakeholders. The evaluation type construct addresses the task level impacts dimension of IT value by identifying three ways an IT system can operate at the task level: process, response and impact. The organization level construct addresses both stakeholder and task level impacts dimensions, identifying different stakeholders and their corresponding scope of activities. Additionally, the evaluative referent construct identifies three different categories of IT value measures.

IS Effectiveness Framework

The IT effectiveness framework proposed by Seddon et al. (1999) takes a different approach to organizing IT value measures. Unlike other post-implementation frameworks that organize IT value measures based on different types of IT impacts, the IT effectiveness framework organizes measures based on the type of IT system being evaluated. Based on the organizational effectiveness framework by Cameron and Whetten (1983), the framework uses stakeholder and system type dimensions to distinguish different IT system deployments.

The stakeholder dimension in this framework is defined as “a person or group in whose interest the evaluation of IS success if being performed” (Seddon et al., 1999, p. 5). Or alternatively, the perspective from which IT value is being considered. The framework proposes five types of stakeholder perspectives:

1. the independent observer who has no stake
2. an individual who wishes to be better off
3. a group who also wishes to be better off
4. managers and owners who want the organization to be better off
5. a country that wants the society as a whole to be better off

The system type dimension defines the scope of the IT system under analysis. Six different scopes are introduced:

1. an aspect of IT use (e.g. user interface)
2. a single IT application
3. a type of IT or IT application (e.g. data warehouse)
4. all IT applications used by an organization or sub-organization
5. an aspect of system development methodology
6. the IT function of an organization or sub-organization.

Based on these two dimensions, a two-dimensional matrix identifies thirty different types of IT value assessments identified by a particular system type (the columns in the matrix) and stakeholder (the rows in the matrix) combination. IT value measures are organized by which type(s) of IT assessments they are appropriate in. For example, metrics for user input errors may be classified in an assessment context where the stakeholder is an individual and the system type is some aspect of an IT system. A metric for macroeconomic productivity in a particular industry may be classified in an assessment type where the stakeholder is an entire country and the system type embraces all of the IT applications used by an organization.

To validate their framework, Seddon et al. (1999) reviewed the IS effectiveness literature written between 1988 and 1996 in the Journal of Management Information

Systems, Information Systems Research, and Management Information Systems Quarterly, attempting to classify empirical measures found in the literature into the different assessments contexts identified by the framework. In total, 186 papers were identified to possess empirical IS performance measures and were classified into the framework. During the classification process, the authors noted that classification "was not always clear cut," (Seddon et al., 1996, p. 13) and suggested that these difficulties can be attributed to weaknesses in the framework and, in some cases, failure by authors to clearly identify the stakeholders and/or the system type under analysis.

In terms of the IT value dimensions suggested in the previous chapter, the IS effectiveness framework addresses the stakeholder and task level impact dimensions. The stakeholder construct identifies different parties affected by an IT system and introduces new stakeholders, such as aggregate groups, that are not addressed by other frameworks. By identifying the scope of a system, the system type construct implicitly addresses the task level impact dimension because system scope implicitly specifies the scope of tasks relevant to an IT system.

2.1.1.3 Critique of Acquisition and Post-implementation Frameworks

Based on the review of IT acquisition and post-implementation frameworks, we can observe two problems with how the literature addresses IT value. These problems are:

- Problem of value dimensions
- Problem of assessment methodology

Problem of Value Dimensions

One of the primary problems with the reviewed frameworks is the inconsistent definition of IT value. Of the six dimensions of IT value suggested in the previous chapter, time and external dependency dimensions are not addressed by any of the reviewed frameworks. Moreover, for the IT value dimensions that are addressed, each dimension is not addressed consistently by each framework. For example, in the stakeholder dimension, the six measures of IT effectiveness (Grover et al., 1996) identifies individual level and organizational level stakeholders while the IT effectiveness framework (Seddon et al., 1999) identifies independent observers, individuals, groups, managers, and countries. The inconsistent and incomplete treatment of IT value is illustrated in table 3 where the contributions of each framework to each the preliminary IT value dimensions are shown.

Table 3. Framework Comparison

	TAM/TAM2 (Davis & Venkatesh, 2000)	**Diffusion Model** (Rogers, 1995)	**IS Success Framework** (DeLone & McLean, 1992)	**Six Classes of IT Effectiveness Measures** (Grover et al. 1996)	**IT Effectiveness Framework** (Seddon et al., 1999)
Time		Product lifecycle User adoption stages			
Stakeholders			Individuals Organizations	Individuals Organizations	Independent observer Individuals Groups Organizations Country
Individual Characteristics	Experience Image Subjective norms	Social forces (interpersonal and mass media communications)	User satisfaction		
Task Level Impacts	Perceived ease of use Job relevance Output quality Result demonstrability	Relative advantage Trialability Observability	System quality Information quality	Unit of analysis	System scope
External Dependencies					
Usage			Use		

These observations suggest that the literature lacks a consistent treatment of the meaning of value, where each IT framework focuses on a particular set of value attributes and overlook many others.

Problem of Assessment Methodology

Another problem is the absence of methodology to develop IT value metrics. Post-implementation frameworks propose basic taxonomies to organize value assessment metrics, but do not describe how metrics should be developed from these categories. For example, the IS success framework (DeLone & McLean, 1992) requires users to select relevant metrics according to the objectives and context of the value assessment (DeLone & McLean, 2003). However, what the context is and how the context affects the selection of metrics is not specified. These are crucial application issues that are not addressed by this framework. The other two frameworks (Grover et al., 1996; Seddon et al. 1999) parameterize the contextual factors of an assessment to identify different categories of metrics. However, these frameworks also do not provide any guidance to develop metrics from their respective categories.

The process of developing metrics may not be a trivial process. For example, consider an information quality metric (from the IS success framework) to evaluate an enterprise resource planning (ERP) system. It is necessary to interpret what information quality means in this particular deployment of ERP. High quality information may imply that the ERP system reports the precise amount of inventory in the warehouse at any given time or that the ERP system automatically calculates all the manufacturing performance numbers that managers need to complete their weekly status updates. Identifying what IT value means in a particular IT deployment requires adapting high level constructs, such as information quality, to very specific contextual factors, such as the need to keep track of inventory very closely or a managers need for specific performance figures. Additionally, once a particular form of value is identified, a metric must be created to investigate that form of value. This brings forth many metric design issues including those suggested in the previous chapter (what phenomena should be measured, where measurement should occur, when measurement should occur, and how measurements should be interpreted). This identifies a substantial gap in post-implementation IT frameworks. While post-implementation IT frameworks identify different types of IT value, how metrics can be developed to investigate these types of IT value is overlooked.

2.1.1.4 Summary of Acquisition and Post-implementation Frameworks

The various value dimensions introduced in the review of acquisition and post-implementation frameworks provides evidence to support the multi-dimensions nature of IT value suggested in the previous chapter. Moreover, in the context of IT value assessment, this review identifies a number of areas in the literature that need to be addressed. These areas are:

- A general framework to approach IT value
- Methodology to develop value assessment metrics

The following sections in this literature review examine the literature regarding these areas.

2.1.2 IT Value Frameworks

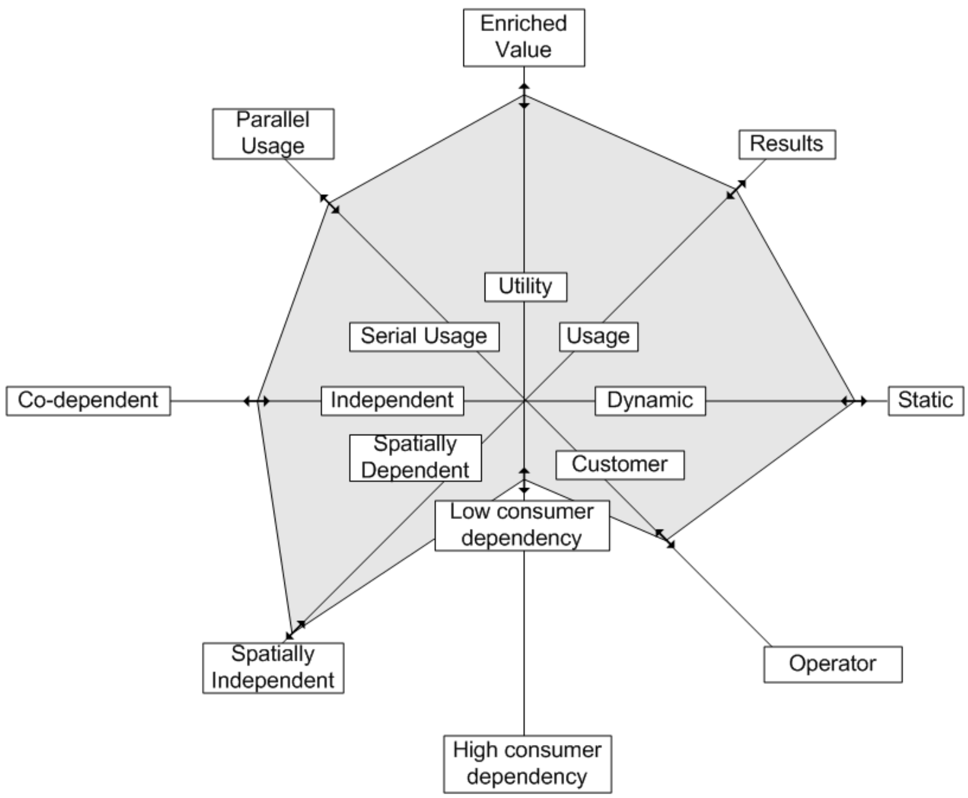
The previous discussion reviewed a number of IT value frameworks and found that each framework approached value differently. Acquisition frameworks naturally focussed on aspects of value related to the adoption of technology. Other frameworks presented taxonomies to categorize different forms of IT value. However, if we consider the problem introduced in chapter 1 of understanding the value of taking a photograph of a child, none of these frameworks address how value can be realized in different situations, such as by the operator when the photograph is taken, by the family after the child has grown up. Acquisition frameworks only focus on the acquisition of IT while the taxonomy frameworks focus on classifying known forms of value and do not provide mechanisms to explore value in different situations. Therefore we introduced an unpublished framework proposed by McKay (2004) and McKay and Ng (2004) that addresses IT value across different temporal and situational contexts. McKay (2004) introduced a number of preliminary constructs to analyze value temporally and across different situations. These constructs were then used to analyze IT value in a consumer electronics context in McKay and Ng (2004). The remainder of this section analyzes the constructs of the McKay IT value model and compares them to the IT value dimensions proposed by the previously reviewed bodies of literature.

The McKay IT Value Framework

McKay and Ng (2004) perform a value analysis that attempts so describe how a consumer electronic may provide value in number of different contexts. To accomplish this, the authors identify a number of attributes that affect how users value a consumer electronic device and use these attributes as the basis for a multi-dimensional value model. To illustrate what these attributes are, consider the consumer electronics example form the Chapter 1. Users will judge the value of a consumer electronic differently depending on whether the consumer electronic serves an enriched or utility function. In one case, the device is considered valuable if its usage provides the user with a conscious feeling of enjoyment. In the other case, the device is considered valuable if it simply performs its function. It should be noted that such attributes will vary according the type of IT being analyzed and the stakeholder perspective from value is defined. For example, the relevant dimensions of value for a health IT system to a patient may include their: prognosis, position in treatment, degree of engagement, degree of system support from care givers, etc.

Within a class of IT systems, a specific IT system can be characterized by where they fall within each of the value dimensions. An aesthetically pleasing DVD player that requires other devices to match its external design may have a high degree of enriched value and a high degree of external dependency. A pocket radio that is used to listen to the news while commuting may have a low degree of enriched value and a low degree of external dependency. These different characterizations of value are described using a polar star diagram where each radial edge represents the range of values within a dimension. A particular type of value can be translated into markings along each radial edge, where the shape given by connecting each of the marks characterizes a particular IT system. Figure 4 from McKay and Ng (2004) provides an example of such a characterization.

Figure 4. Value Model Example



The value models proposed by McKay and Ng (2004) are underpinned by the value framework concepts introduced in McKay (2004). In this framework, McKay (2004) presents a taxonomy of different temporal and situational contexts in which value can be realized from IT. This taxonomy provides a foundation for identifying the value attributes used in the value models of McKay and Ng (2004), where assessors use the taxonomy to identify relevant aspects of value for the IT system being assessed. At its highest level, the taxonomy consists of five broad areas:

- Life cycle positioning

- Society or organizational structure
- Interactions
- Information conveyed via the interactions
- Physical, social, or personal impact

Life Cycle Positioning

Life cycle position addresses how the maturity of an IT system can affect the value users derive from it. To expand upon this concept, McKay (2004) discusses three aspects of life cycle positioning: cycles, dynamics and issues. Cycles describe how IT proceeds through multiple stages of evolutions, from being an idea to a technical concept, a prototype, early adopter usage, widespread usage, and ultimately decline. Dynamics describe the various forces that may be acting upon an IT system during its evolution. One possible dynamic is the transition from being an exclusive novelty item to a commodity product. Another possible dynamic is institutionalization, where a form of IT is ingrained into an organization or culture. When thinking about the lifecycle of a form of IT, the issues aspect identify five questions that may be useful to consider: What starts or delays each cycle? Are cycles push or pulled? What are the stimulants and retardants to trigger a cycle? What are the stimulants and retardants to sustain a cycle? Can the evolution be planned, anticipated, or controlled?

Society or Organizational Structure

Society or organizational structure addresses who is using the IT system and why they are using it. This goes beyond identifying the stakeholder as other frameworks have discussed and specifies the role of the IT system for the stakeholder. Here, the framework identifies four major roles: personal and family, leisure, formal role within society, and external formal interactions. Personal and family represent IT systems that are used in day to day activities for basic survival or to cultivate family interactions and companionship. The leisure role describe forms of IT that support recreational activities such as hobbies or vacations. Forms of IT that fall into the formal role within society category are systems that support vocational roles such as being a student, employee, at-home spouse, or retiree. Forms of IT that fall into the external formal interactions are the systems that manage formal relationships between different entities such as retail websites that serve as the intermediary between the customer and retailer.

Interactions

Interactions focus on how users will interact with a form of IT. Here, McKay (2004) breaks down interaction into three components: form, purpose, and characteristics. Form describes the style of the interaction, such as the initiator, the flow of information, and the dominant and submissive roles. Broadcasting information represents a fundamentally different style of interaction than one on one contact. Purpose addresses why the interaction is occurring. Why is the interaction initiated? Why is information being sent? Why is information being consumed on the other end? Characteristics address specific details of the interaction such as norms, expectations, and dependencies.

Information

Information focuses on the information being transmitted through a form of IT. Here, McKay (2004) discusses four aspects of information: purpose, attributes, information life cycle, and control. Purpose considers what the information is used for. Attributes consider different aspects of the information such as whether there is too much or too little, timely or tardy, accurate or inaccurate, and complete or incomplete. Information life cycle describes the source of the information and where it is headed. For example, the purpose of an IT system may be to create, transmit, store or aggregate information. Control considers how an IT system affects the control over that information. For this, relevant issues include the accessibility of that information, whether the information can be stolen, whether the information can be altered, and so forth.

Impact

The last construct of the McKay IT Value Framework discusses the various ways in which a form of IT can impact its users. In the framework, seven aspects of impact are discussed: initiation, facilitation and continuance, source of impact, who and what is affected, potential and scope, dynamics and control, and dependencies. Initiation considers what starts an impact while facilitation and continuance considers what is needed to for an impact to continue. Source of impact considers the mechanism that causes the impact, such as a different delivery mechanism or new information. The various entities that can be impacted and how they are impacted are discussed in who and what is affected, while potential and scope consider the implications of the impact and its pervasiveness. Dynamics and control identify various ways in which the impact may change and how the impact can be managed. Lastly, dependencies identify the potential implications of being dependent on a form of IT.

While this review briefly defines each of these areas, readers are directed to McKay (2004) for a more detailed discussion regarding each of the discussed areas. While many of these topics may not be relevant for every IT system, the primary function of the value taxonomy is to provide assessors with a checklist of the various aspects that need to considered when investigating why an IT system is value.

With respect to the preliminary IT value dimensions proposed in Chapter 1, it is evident that the IT impact framework by McKay (2004) encompasses all of the preliminary value dimensions discussed in our review of IT value literature. The role of time in IT value is discussed in the lifecycle positioning category and also in the interaction category, where the timing of interactions is discussed. Different stakeholder dimensions are illustrated in the society and organizational structure where the role of the user is considered. Individual characteristics are indirectly addressed in the interaction and information categories, where user centric characteristics such as interaction norms and information purpose are discussed. The role of usage in realizing IT value is addressed by how the framework considers the form and characteristics of interactions. External dependencies are directly addressed by the discussion regarding the dependencies of an IT impact. Lastly, how tasks are impacted by an IT system is addressed by how different value models are used for different IT systems and through various interaction, information, and impact sub-categories.

In summary, the approach to defining value presented by McKay (2004) and McKay and Ng (2004) differs significantly from how value has been approached in existing IT value literature. Unlike acquisition and the taxonomy frameworks reviewed earlier, the McKay IT Value Framework provides a different approach to understanding IT value, breaking value down across different situational and temporal contexts. In comparison to how acquisition and post-implementation frameworks address IT value, the proposed impact framework (McKay, 2004) addresses IT value in a significantly more broad and complete manner, addressing each of the preliminary IT value dimensions through its model development methodology. However, in the problem context of assessing IT value, a holistic model of IT value is only one of two majors problems identified earlier. The next section investigates the second problem, examining the literature regarding metric design.

2.2 Review of Metric Design Literature

Chapter 1 introduced a number of issues regarding the development of metrics to assess IT value. This section examines how these issues are addressed by the literature. In particular, we focus on the basic principles of metric design for evaluating organizational effectiveness.

What phenomena should be measured, where measurement should occur, when measurement should occur, and how measures should be interpreted are just a few of many possible questions assessors face when designing metrics to assess IT value. Some insight into addressing these questions is provided by Eccles (1991), Kaydos (1991), Lynch and Cross (1991), and Camp (1995) who argue that measures should reflect an organization's goals or corporate strategy. The rationale being that such measures indicate organizational performance in areas that are relevant to the organization.

Camp (1995) provides a conceptual framework to design evaluation metrics based on this paradigm. Consistent with other works in the literature (Walrad & Moss, 1993), the framework identifies two types of measures: result measures that measure a particular outcome and process measures that measure the practices that lead to that outcome. The framework emphasizes the importance of process measures to accompany result measures in a suite of metrics for reasons of credibility and future improvement. Camp (1995) observes that, on their own, result measures are often regarded as just numbers that do not provide accurate insight into what is going on. This is exemplified by Eccles (1991) and Stata (1989) who criticize financial measures for these very reasons. Process measures address this problem, providing insight into how results are obtained. Additionally, Camp (1995) reasons that process measures also facilitate continuous improvement by monitoring how well things are working.

In order to develop process measures, Camp (1995) proposes that it is necessary to understand the processes that an organization is composed of and how processes interact with one another to produce the organization's outputs. Such a model forms a basis to address metrics design issues such as those suggested earlier. This approach is also supported by Georghiou and Roessner (2000) who use a similar conceptual model as a means to evaluate public programs for stimulating technology use.

The first part of the framework involves interpreting the goals of the organization and identifying satisfiers and dissatisfiers that contribute or detract from those goals. For example, a possible organizational goal may be customer satisfaction while a possible dissatisfier of that goal may be the need for technical support. It should be noted that such an analysis already provides insight into how assessment metrics should be developed.

The next part of the framework consists of developing a high level process model of an organization and linking the process model to the goals of the organization. To construct the model, processes are specified in terms of the activities they entail and linked in terms of their inputs and outputs. Then, the set of relevant processes that contribute to each organizational goal is identified. This exercise identifies where measurement efforts should be focussed. Measurement efforts can be further focussed according to goal priority, where measuring resources are allocated to processes that affect the most significant organizational goals.

The last part of the framework involves determining key performance indicators for the remaining set of processes. Consistent with Zairi (1994), the framework suggests that indicators can be interpreted from different perspectives, both internally and externally. Further insight into what and where measurement should occur is revealed by considering process outputs and in-process activities. Additionally, assessors can consider the time period before, during, and after a process in determining when measurement should occur.

In the context of assessing the value of an IT system, there are significant incompatibilities that prevent the Camp (1995) framework from being used directly. Fundamentally, the Camp (1995) framework aims to develop measures to assess the effectiveness of an organization while the problem context of this thesis is to assess the value of an IT system. This illustrates major differences in terms of the target and purpose of the investigation. For the framework, the target under investigation is an organization while our problem context has no such limitation on the target entity. Moreover, the framework aims to investigate how an organization is performing while our problem context aims to investigate how an IT system affects various target entities. However, despite these incompatibilities, the framework provides insight into how metrics can be designed to investigate IT value. In particular, the measuring of both results and the processes that produce those results as well as using a process model to guide metric design are significant contributions that can be applied to our problem area.

2.3 Summary

Chapter 1 introduced the problem context of assessing IT value and introduced two problems: what is IT value and how can it be measured. This section reviewed the literature regarding these problems and identified significant contributions from the literature to address these problems. The first question was partially addressed though a model of IT value that is more dimensionally complete than what is typically found in IT literature. The second question was partially addressed through an evaluation methodology obtained from organization effectiveness literature. However, these answers do not provide a complete solution to assessing IT value. There remains a significant gap between how IT value is defined in the McKay and Ng (2004) framework and measurement methodology proposed by Camp (1995). The remainder of this thesis will focus on this middle ground, developing a systematic methodology for applying the measurement concepts introduced by Camp (1995) to assess IT value, as defined by McKay and Ng (2004).

Chapter 3:
Theory Development

Chapter 2 reviewed the literature to answer two main questions regarding IT usage: what is value and how can value be measured? The review found that models of IT acquisition and impact have different notions of what IT value is. Subsequently, we introduced a preliminary IT value model by McKay and Ng (2004) that encompasses these notions of IT value. Additionally, the review examined business performance measurement literature, particularly the business process measurement methodology by Camp (1995). This chapter bridges the business process measurement measurement concepts introduced by Camp (1995) with the IT value framework proposed by McKay and Ng (2004) to develop a framework for assessing IT value.

The assessment framework introduced in this chapter provides a systematic method for analyzing the value of an IT system and will be referenced as the SIVA (systematic IT value assessment) framework. The SIVA framework aims to provide a logical method for identifying potential forms of positive and negative value caused by an IT system. For example, given a health information portal in a hospital environment, the SIVA framework provides a mechanism to identify how the stakeholders of the hospital may find positive and negative value from the portal. Note that the assessment framework does not claim to provide metrics to validate these potential forms of value. Once the potential forms of IT value are identified, metrics can be developed to quantify the value.

However, metric development is beyond the scope of this framework and is the subject of future research.

The SIVA framework is composed of three submodels and a methodology that ties these models together. These submodels are:

- Stakeholder value model
- Process flow model
- Information flow model

The stakeholder value model identifies the different stakeholder perspectives from which value is being assessed. In any given IT deployment, there are different stakeholders that have their criteria for assessing value. For example, consider the stakeholders of a virtual private network (VPN) which may include the employee that uses the system, the employee's manager, and the employee's family. Each stakeholder has their own evaluation criteria. The employee may find value if the system works without any technical errors; the family may find value if it enables the employee to spend more time at home; the manager may find value if it allows projects to finish earlier. The stakeholder model draws from the IT value framework by McKay and Ng (2004) to capture and elaborate on these perspectives in a structured manner.

The process model describes the environment that the IT system will be deployed within. This description is based the process measurement concepts introduced by Camp (1995), where the deployment environment is described as a series of interrelated tasks. To illustrate, consider a customer relationship management (CRM) system to be deployed in a commercial business. The corresponding process model would describe the various activities that are performed within the business such as production, distribution, support, etc., and identify how those activities are interrelated.

The information audit model augments the process model by describing how information is used in the deployment environment. The model describes how each task interacts with information in terms of information inputs, outputs, transforms, storage, etc. For example, in a restaurant environment, a customer's order information may be: created when the waitress takes an order, used by the cook to prepare the food, and transformed by the cashier to calculate the bill.

The methodology component ties these three models to create a process driven method for assessing IT value. This methodology component can be viewed as two parts: IT system impacts and stakeholder implications.

IT system impacts are objective changes in how activities are performed differently and information is altered due to the introduction of an IT system. The SIVA model views IT system impacts as changes to the activities and information flows that comprise the process flow and information audit models. Examples of IT system impacts include eliminating a particular task or changing the delivery mechanism of a piece of information.

Stakeholder implications describe the significance of IT system impacts to stakeholders. The SIVA model views stakeholder implications as relevance of each IT system impact to the value dimensions of each stakeholder. For example, to understand the significance of a new information delivery mechanism, we can consider how it affects the different aspects of value for the information's creator, consumer, or distributor.

The SIVA methodology itself is a two stage sequential analysis of these components. It first identifies the IT system impacts by iterating through the process flow and information audit models. Then it examines the significance of each IT system impact to the value dimensions of each stakeholder.

With respect to the McKay and Ng (2004) value model and Camp (1995) measurement framework, the sequential analysis prescribed by the SIVA framework bridges the measure concepts introduced by Camp (1995) with the value concepts introduced by McKay and Ng (2004). The SIVA framework operationalizes the Camp (1995) measurement concepts through utilizing process flow and information audit models to understand how an IT system is used. Additionally, the value concepts introduced by McKay and Ng (2004) value concepts are operationalized through the multi-dimensional value models for each stakeholder. The methodology component of the SIVA framework bridges these concepts together by prescribing how the models derived from these two concepts can be sequentially analyzed to provide insight into the value of an IT system.

The follow sections discuss each submodel and the methodology component in greater detail.

3.1 Stakeholder Value Model

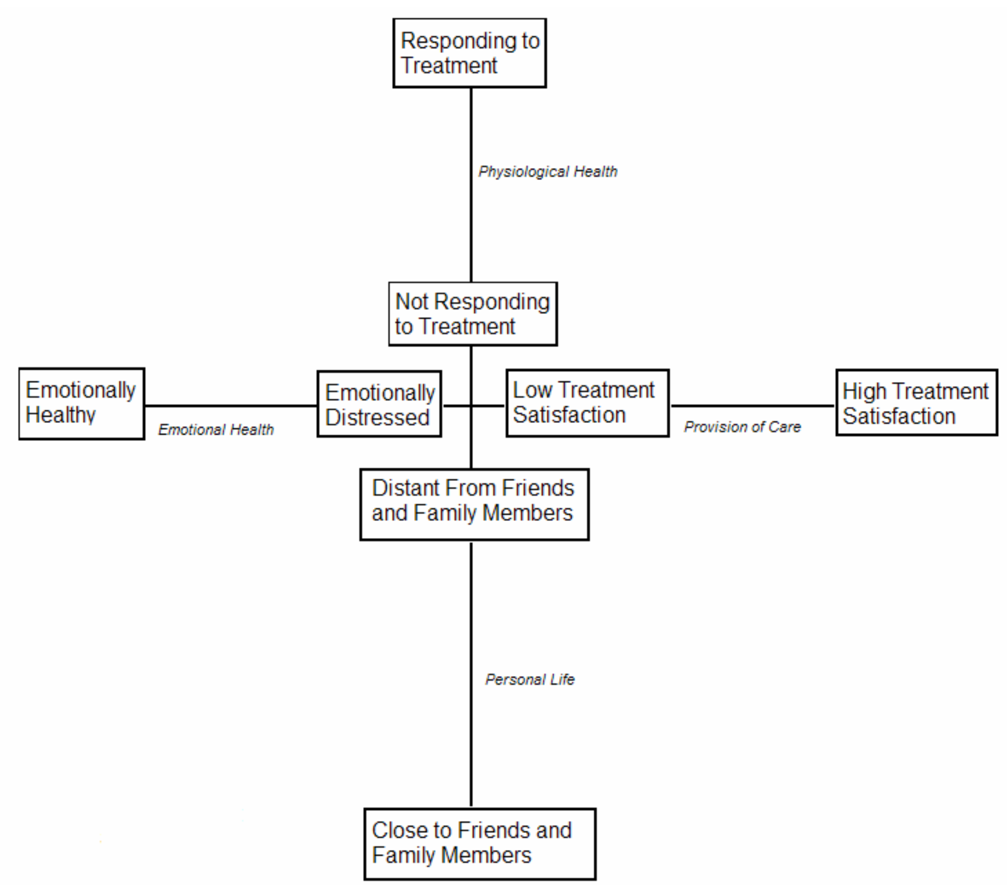
Chapter 1 defined the concept of IT value as assessing the usefulness of an IT system and discussed the different aspects of usefulness through the six proposed dimensions of IT value. In keeping with this, the stakeholder value model describes what it means for an IT system to be useful for each stakeholder.

In a typical IT system deployment where multiple stakeholders are involved, multiple models are necessary to reflect what usefulness means to each stakeholder. The distinction between stakeholders is necessary because different stakeholders will assess usefulness based on different factors. For example, a business owner may assess the value of an ERP system based on return on investment (ROI) factors while employees may assess the same system based on day to day usage.

Note that how an IT system's user base is divided into different stakeholders is not prescribed by this framework. This is because the set of relevant stakeholder groups will vary according to the scope of the value assessment being performed. Chapter 2 illustrates a number of ways to group stakeholders, such as by the level within an organization (Grover, 1996) and by size of the stakeholder group (Seddon et al., 1999). Other stakeholder groupings are also possible. For example, the relevant stakeholders of a health IT system may be patients, patient families, doctors, nurses, and the hospital administration.

The stakeholder value model itself is drawn from the concepts introduced by McKay and Ng (2004). For a given IT system, it is composed of the different aspects of usefulness for a particular stakeholder. In the case of a patient undergoing cancer treatment, these factors may be emotional well being, physiological well being, facilitation of care, and relations with friends and family members. One way to visualize the model is through a polar star diagram, where each radial edge represents the spectrum of possibilities for a particular aspect. For physiological well being, the radial edge may span patients with that are responding well to treatment to patients that are deteriorating. The number of edges is not fixed as it should reflect the detail level of the value assessment. Figure 5 is drawn from the case study portion of the thesis and illustrates the value model for a cancer patient.

Figure 5. Cancer Patient Value Model



The development of such a value model is contingent on the ability to identify relevant aspects of value. McKay and Ng (2004) utilize the taxonomy of IT impacts by

McKay (2004) as a starting point to identify aspects of value. While the taxonomy lists many factors that influence stakeholder value, we recognize that identifying relevant factors requires a strong understanding of what value means to each stakeholder which is beyond the scope of this assessment framework.

Creating such models provide significant insight into the meaning of value for an IT system. The assessor must identify who the relevant stakeholders are and consider how each stakeholder defines usefulness. By capturing this information into the corresponding value model, an explicit declaration of what constitutes value on a per stakeholder basis is created.

3.2 Process Model

The purpose of the process model is to describe the environment that the IT system is being deployed in. The SIVA approach to describing the deployment environment is motivated by Mintzberg's (1979) who states:

"Every organized human activity -- from the making of pots to the placing of a man on the moon -- gives rise to two fundamental and opposing requirements: The division of labour into various tasks to be performed, and the coordination of these tasks to accomplish the activity."

The ability to break activities down into tasks and their coordination, naturally suggests that activities can be described in terms of a network of tasks. From the literature review in Chapter 2, Camp (1995) takes a similar approach, using a process model to develop business process metrics.

One possible representation of the process model is a state transition diagram, where each state represents a task and each arc represents the conditions necessary for a task transition. The following figure provides an example of this approach that is drawn from the case study portion of this thesis.

Figure 6. Cancer Treatment Process

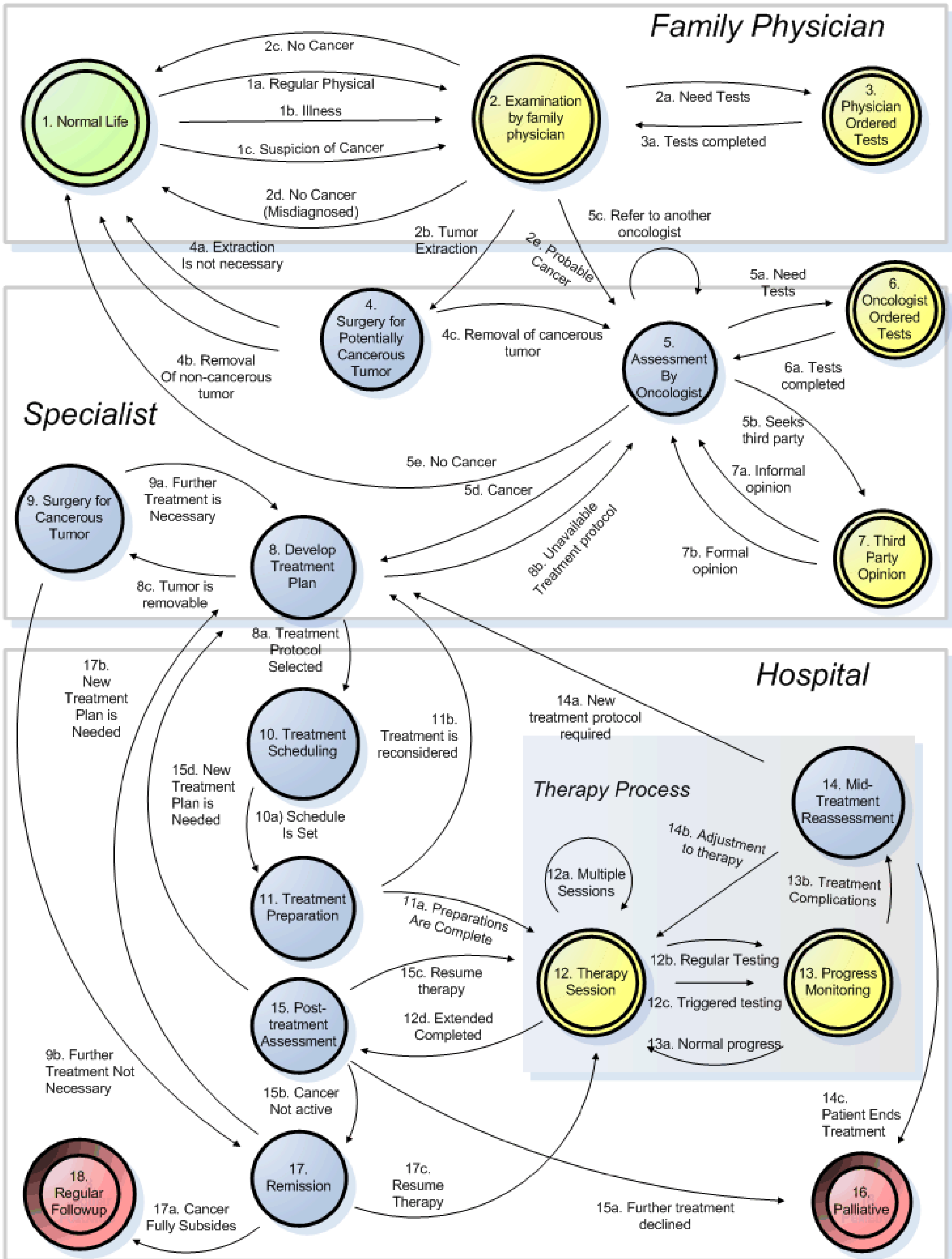


Figure 6 illustrates how the cancer treatment process can be broken down into a network of tasks. In this particular example, the tasks are organized into three blocks according to the primary provider of care. The family physician block entails tasks such as leading a normal life and getting examinations for cancer. The specialist block entails tasks such as being assessed by an oncologist and developing a cancer treatment plan. The hospital block entails tasks such as scheduling treatment, undergoing therapy, and monitoring progress.

It is important to consider the scoping, or detail level, of these activities. Some assessments may examine the value of an IT system to a particular manufacturing process while another may examine the value of an IT system to an entire nation. Consistent with the variable scopes discussed by Grover et al. (1996) and Seddon et al. (1999), the scope of the process model should be adjusted according to the needs of the actual assessment. This means that some process models may define a task as an explicit physical action such as filling in line 3 of a registration form while another process model may define a task as a broader activity such as collecting user information.

3.3 Information Flow Model

The information flow model augments the process model by describing how tasks interact with information. This is necessary because IT systems can affect the information that tasks interact upon instead of the task itself. For example, consider how a student is affected by replacing a DVD based encyclopedia with a wiki[1] based encyclopedia. The task of researching is not changed significantly since the student continues to use a computer and similar search mechanisms to find relevant information. Instead, the primary differentiator between the two scenarios is in information content. The communal nature of a wiki based encyclopaedia affects the quantity, quality, and

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[1] A website that allows users to add and edit content collectively

relevance of information being researched. The open nature of a wiki allows numerous parties to contribute information, potentially increasing the overall breadth and depth of the content. Conversely, the open nature of a wiki also allows for inaccurate or false contributions that are not corrected until knowledgeable readers notice and report them.

In addition to quantity, quality, and relevance, there are a number of other information characteristics that can be affected by an IT system. From Chapter 2, the IT impact framework by McKay (2004) identifies four major types of information characteristics:

- Purpose characteristics
- Instance specific characteristics
- Life cycle characteristics
- Control characteristics

Purpose addresses why the information is being used in the first place. For example, when a patient researches cancer treatment information from home, are they gathering information to choose their course of treatment, or are they gathering knowledge to appease their fear of an unknown outcome?

Recognizing that not all instances of a piece of information are the same, instance characteristics describe each instance. This includes characteristics such as accuracy, completeness, quantity, and timeliness. An example of this is cancer therapy information. The information itself exists in a number of different forms, such as physician knowledge, research journals, and information pamphlets, but each form differs in terms of precision, quantity, readability, etc.

Lifecycle characteristics describe where the information is coming from and where it is headed. When a patient researches their treatment information from home, the information can be coming from their care provider, an online health site, a personal friend, etc. Additionally, once the information is obtained, where will it be used? For example, a patient's own research may influence how they interact with their physician during consultations.

Control characteristics describe the accessibility of that information to different parties. This includes who can access or modify a piece of information. It also encompasses security aspects such as eases of theft, distribution, etc. An example of this is a patient's test result. Does the care provider or patient have ownership over the result? Should patients be able to access their test results anytime they wish?

To exemplify the concept of an information flow model, the following tables illustrate the information flow analysis for the oncologist assessment task in Figure 6.

Table 4. Information Inputs and Outputs

Inputs	**Outputs**
• General information about cancer (survival rates, treatment, etc.) • Patient medical history • Patient family history • Test/scan results*	• Assessment of cancer severity

Table 5. Information Usage

Information	User	Purpose	Frequency	Trans. Issues
General Cancer Information	*Patient/Family*	*Improve knowledge, thereby decreasing fear, anxiety*	*Sometimes*	*Inaccurate or incomplete*
Patient medical history	*Oncologist*	*Provides background information for assessment*	*Always*	*Incomplete or inaccessible?*
Patient family history	*Oncologist*	*Provides background information for assessment*	*Always*	*None*
Test/Scan results	*Oncologist*	*Used in the assessment of cancer severity*	*Always*	*None*
Test/Scan results	*Patient/Family*	*To increase participation in the treatment process*	*Sometimes*	*Comprehension*

Table 4 shows the information inputs and outputs when an oncologist is performing an initial assessment of a patient's cancer condition. During this activity, an oncologist will consider the patient's medical history, family medical history, and test results to determine the type and severity of the patient's cancer. Additionally, the patient will typically inquire about the survival rate and treatment for the suspected form of cancer. This information is listed under information inputs in Table 4. The oncologist's assessment of cancer type and severity is listed under information outputs in Table 4. Table 5 describes the user, purpose, frequency and transmission issues of the information inputs in Table 4. The first row refers to general cancer information, which is sometimes used by patients and family to improve their knowledge and decrease anxiety regarding the suspected disease. Additionally, the general cancer information being consumed by patients and family members has the potential to be inaccurate or incomplete. The second row refers to the patient's medical history, which is always used by the oncologist to provide background information for the assessment. This information has the potential to be incomplete, or in some cases, inaccessible. The remaining rows in Table 5 follow the same pattern, describing the user, purpose, frequency, and transmission issues for a patient's family history and medical test results.

In summary, the three models that underpin the SIVA framework describe different factors that influence the value of an IT system. The stakeholder value model describes the different criteria used by stakeholders to determine usefulness. The process flow model describes the various activities that the IT system must integrate into. The information audit model describes the information interacted upon by the activities in the process flow model. The methodology component of the SIVA framework leverages these three models to provide a systematic IT value analysis tool. By systematically analyzing how an IT system may impact the process flow and information audit models, then evaluating those impacts from the value criteria presented in the stakeholder value models, we can obtain significant insight into the value provided by an IT system. The next section describes this methodology component in greater detail.

3.4 Methodology

Once these models are created, the methodology component of the SIVA framework describes how these models can be used to analyze the value of an IT system. The aim of this methodology is not to prescribe specific value metrics, but to provide a systematic way of isolating and identifying potential forms value and non-value.

This methodology can be broken down into two stages. The first stage involves analyzing how the IT system objectively impacts the tasks and information flows within its deployment environment. The impacts identified in this stage are called IT system impacts. The second stage analyses how each IT system impact affects the value dimensions of each stakeholder value model. From a broader perspective, the first stage examines how an IT system is being used and the second stage examines how that usage is significant to each stakeholder.

3.4.1 Task and Information Impacts

To understand how an IT system is being used, the SIVA framework leverages the process flow and information audit models of an IT system deployment. Usage can be systematically analyzed by considering how the IT system affects each task in the process flow model and the information flows associated with that task. For the process flow model, this means examining how the tasks are performed differently due to the IT system under analysis. Additionally, we consider how the information inputs and outputs of each task are affected by the IT system under analysis.

To demonstrate how an IT system may affect a task in a process flow, consider how a barcode reader affects a checkout task in a grocery store. The checkout task, where a cashier calculates the price of the goods being purchased and collects payment customers, is one of many tasks that are typically necessary to run a grocery store. A barcode reader affects this task by changing the way product price information is entered. The process of the cashier manually reading the price label and entering it in digit by digit is replaced by the cashier applying the barcode reader to the price label. This makes it no longer possible to enter the wrong price information and reduces the number of manual actions performed by the cashier. Deploying such a system also adds processes for creating and maintaining a database to associate barcodes with product prices.

Tasks can be impacted by an IT system in a variety of ways. To categorize the different task impacts that may occur, we draw from McKay (2004) who identifies three general aspects of interacting with an IT system: form, purpose, and characteristics. These three aspects provide a starting point to consider how a task is impacted by an IT system. The first aspect, form, describes the basic structure of the interaction, such as the initiator, the number of parties involved, and the relationship between those parties. For an example of a form impact, consider how the shift from telephone service to instant messaging (IM) service enables users to converse with multiple people simultaneously. Purpose describes a user's motivation for using the IT system in a particular task. The previous example of a cashier using a barcode scanner illustrates a purpose based impact, where the scanner was used to input price information and consequently altered the price input process. Characteristics is a broader category that describes the peculiarities of interacting with an IT system, such as norms and expectations. An example of characteristic impact is how the introduction of e-mail into a work place causes workers to become tethered to their e-mail systems.

The next aspect of IT system usage is how the information consumed and produced by tasks can be affected by an IT system. For example, consider the barcode reader example presented earlier. The product pricing information is an information input to the checkout task that enables the calculation of how much the customer pays. The introduction of a barcode scanner affects pricing information being inputted because it prevents incorrect pricing information from being keyed in. Consequently, the overall accuracy of price inputs and price total outputs in the checkout task would likely increase.

To analyze how information can be affected by an IT system, McKay (2004) presents four aspects of information: purpose, attributes, life cycle, and control. Purpose describes why a particular information flow exists, such as why price inputs are necessary in a checkout task. The attributes aspect describes the characteristics of information, such as its accuracy, timeliness, and completeness. Lifecycle describes whether information is being created, transformed, stored, destroyed, etc. Control describes the accessibility of information to various parties and the policies regarding information access. These four aspects identify different types of information impacts that can be caused by an IT system. The increased accuracy of price inputs and calculations in the barcode reader example demonstrate how an IT system can affect the attributes of information. The lifecycle aspect of a user's electronic data is affected by a data backup system because it alters how long that data may exist for.

To summarize, the SIVA framework attempts to understand how an IT system is used by analyzing how it affects the elements of the process flow and information audit models. For tasks in the process flow model, the SIVA framework examines how each task in the process flow is affected by the IT system based on the three aspects IT system interaction identified by McKay (2004). Similarly, for information flows in the information audit model, the SIVA framework examines how each information flow is affected by the IT system based on the four aspects of information identified by McKay (2004). While the constructs identified by McKay (2004) guide this analysis process, we recognize that discerning actual impacts requires domain specific knowledge that is beyond the scope of the SIVA framework. The systematic analysis process proposed in this section is meant to guide assessors possessing such knowledge to systematically analyze the utilization of an IT system. In comparison to ad hoc or brainstorming style of analysis, and assuming the appropriateness of the process flow and information audit models, the SIVA method should prove a more thorough and complete analysis of the potential sources of IT system impact.

The outcome of this iterative process should be a list of possible task and information impacts which we call IT system impacts. Based on the cancer treatment process and information flow examples presented earlier, some IT system impacts caused by a patient health portal may be:

- patients obtain care information through the website instead of other sources
- patients spend more time researching their illness at home
- patients interact with their physician differently because they feel more knowledgeable

Once potential IT system usage behaviors are identified through this process, the next section considers how the identified usage may drive stakeholder value.

3.4.2 Implications on Stakeholder Value

The second part of this methodology framework analyzes how stakeholders are affected by the identified task and information impacts. This is necessary because the impacts, on their own, only indicate how an IT system may be used and does not indicate how it may be useful to stakeholders. To understand usefulness, the SIVA framework analyzes how task and information impacts affect the value dimensions of each stakeholder value model.

This analysis process consists of iterating through the task and information impacts and considering how they affect the dimensions of each stakeholder value model. For example, consider the value model for a cancer patient shown in Figure 5 and a task impact such as a patient being able to access their care treatment information from home. We can consider the significance of this task impact with respect to each of the patient's value dimensions: mental condition, physical condition, healthcare environment, and daily life. With respect to mental condition, a patient may feel more empowered because they have more visibility into their care or they may feel more intimidated because they are uncomfortable with technology. With respect to healthcare environment, a patient may interact with their care providers differently because the website helped them to be more informed about their care.

By performing this analysis for each stakeholder, significant insight into stakeholder value is revealed. In addition to revealing how tasks and information flows may be affected by an IT system, this stage of the analysis links these IT system impacts to different stakeholders and identifies their potential significance. The next logical step (that is beyond the scope of this thesis) is to develop metrics based on this information to investigate and quantify these potential forms of IT value.

3.5 Propositions

The SIVA framework aims to provide a logical method for identifying IT value. In comparison to ad hoc approaches that lack similar structure, we propose that our systematic methodology provides significant advances in the following areas:

I. Understanding What Value Is
II. Understanding How Value Is Created
III. Understanding How Value Can Be Measured

3.5.1 Understanding What Value Is

Since IT value is defined as the usefulness of an IT system, it is important to consider from what perspective is usefulness being judged. A single IT impact can have multiple perceptions of usefulness. For example, consider an IT system that provides medical test results to patients. Patients may find value with such a system because it provides increased visibility into their treatment. Physicians may find value with the system because it allows their patients to be more knowledgeable. Alternatively, physicians may also find negative value with the same system because it increases the likelihood of patient confusion. Focusing on one of these stakeholder perspectives while neglecting the other perspectives may lead to dramatically different value assessments. Consequently, in order to accurately assess the value of an IT system, it is import to consider the various perspectives of each stakeholder.

The assessment framework proposed in this thesis addresses this issue by incorporating stakeholder value models and providing an operational setting for the socio-technical model of McKay and Ng (2004). Because the assessor must consider the significance of each IT system with respect to multiple value dimensions of each stakeholder, the likelihood of overlooking a particular stakeholder perspective is significantly lessened. Moreover, the explicit linkage between IT system impacts and stakeholder value dimensions provides defendable justification for each form of value.

In comparison to ad hoc assessment methods where no explicit stakeholder analysis is done, we would expect the proposed framework to provide a richer understanding of value through: (1) specifying what value means to each stakeholder and (2) providing justification for each form of value.

3.5.1 Understanding How Value Is Created

When assessing the value of an IT system, the possibility of overlooking certain IT system impacts exists. An IT system may generate stakeholder value at one task while reducing stakeholder value at another. For example, a patient portal may provide value to patients by enabling access to treatment information from home but reduce patient value because it eliminates certain interactions between the patient and care provider. When assessing the value of such a system, accounting for one impact while overlooking the other can lead to significant discrepancies between measured and realized value. Consequently, one major challenge of assessing IT value is accounting for all of the major impacts caused by an IT system.

Consider how such a challenge can be reasonably addressed. More specifically, what condition must be satisfied before an assessor can reasonably claim that all major IT system impacts have been considered? For ad hoc assessment methods that do not have a logical analysis method, there is no mechanism to guide the analysis or mark its completion. Consequently, there is a potential for overlooking certain impacts and uncertainty around the completeness of the results.

The assessment framework proposed in this thesis explicitly addresses this issue by incorporating the process and information flow models. The process and information flow models structure the analysis such that the assessor examines how the IT system impacts each task process and information flow. This is advantageous because it provides a mechanism to guide the analysis and mark its completion. Assessors are able to systematically identify impacts by iterating through tasks and information flows, and the completion of the analysis is found when all of the tasks and information flows have been examined. Additionally, the scope and depth of the analysis can be partially inferred from the scope and depth of the information and task models driving the analysis.

In practice, if both the proposed assessment framework and an ad hoc method were used to evaluate the same IT system (with all other factors held constant), we would expect the proposed framework to identify IT impacts that were overlooked by the ad hoc method. However, we do not claim that the proposed framework will always provide a more comprehensive impact analysis than an ad hoc method. It is likely that an ad hoc assessment performed by an expert can be equally or even more comprehensive than a novice using the proposed framework. However, in such cases, it is also likely that the expert has internalized the process and information flow models that underpin the proposed framework.

3.5.3 Understanding How Value Can Be Measured

The last proposition addresses how value can be assessed and measured. The first two propositions address the general analysis challenges of how to view the situation - the value chain of the information system and potential values. These improvements are necessary to proceed from ad hoc analyses in which aspects are overlooked or erroneously emphasized. The benefits can also be seen in a richer view of value and how value is obtained by various stakeholders. The third proposition investigates the identification and measurability of identified forms of value; or more specifically, where and when to measure a particular form of value. For example, if an IT system is claimed to improve organizational efficiency, what should be measured to investigate that claim? Where in the information flow can such measurements take place? When should the measurements be made? A challenge for any measurement is: does such a measurement accurately indicate realized value? The focus of the SIVA framework is on the values obtained after the system is deployed and is not on the expected benefits used to justify the development or purchase (e.g., ATAM). In an empirical setting, many things can be counted, grouped, checked-off, or timed, but what is really being measured and what can the measurement be used for? An initial goal set for the system might not be measurable, or the mechanisms are not set in place for data to be collected. It is suggested that by using the SIVA framework that measurement points can be better identified and that a better matching can be made between claims for values derived and evidence supporting those claims.

To summarize, there are two significant issues to consider: what should be measured and how much do those measures tell us about the value in question? The proposed assessment framework addresses these issues by taking a bottom-up approach to analyzing IT value. Starting with basic models of the stakeholder and deployment environment, the framework first identifies objective IT system impacts and then proceeds to analyze the significance of those impacts to stakeholders to identify value. By employing this approach, a "reasoning trail" that links specific process and information flow impacts to particular aspect of stakeholder value is created. Investigating a particular form of value then becomes a matter of placing measures along this trail, such as questionnaires at the stakeholder level and objective metrics at the process and information flow level.

In comparison to ad hoc methods that lack such a "reasoning trail," we expect the proposed framework to identify forms of value that are significantly more measurable. In particular, issues with using the wrong measures or not having any measures to investigate a form of value can be largely avoided through this approach.

3.6 Summary

Chapter 2 reviewed IT value assessment literature and identified two concepts that are relevant to this topic: multi-dimensional value models (McKay & Ng, 2004) and business process measurement (Camp, 1995). This chapter bridges these concepts by developing a framework for assessing IT value. The proposed assessment framework provides a systematic method for identifying potential forms of value provided by an IT system. Additionally, this chapter proposes that the systematic approach taken by this framework mitigates some of the issues that arise from assessing value in an ad hoc manner. The following chapter investigates these propositions through a field study of an IT system deployment.

Chapter 4:
Research Design

Chapter 3 introduced the SIVA framework that operationalizes the concepts of the McKay IT value framework using the business process measurement concepts by Camp (1995). The SIVA framework also claims that it provides advantages over ad hoc value assessment methods in three key areas: analyzing IT system impacts, analyzing stakeholder value, and identifying measures to investigate value. This chapter describes the research methodology that will be used to investigate the SIVA framework and its propositions.

4.1 Research Method Selection

The primary objective of this study is not to prove the validity of the SIVA framework but to investigate whether it makes sense to combine the McKay IT Value Framework with the process measure concepts by Camp (1995).

This investigation will employ a case study research method. The selection of the case study method is based on the conditions for different research strategies proposed by Yin (1984). Here, Yin (1984) proposes that a case study is most appropriate for research where:

- The goal is to under why or how something happens
- The focus is on contemporary events
- The investigator has no control over the events

These conditions match the research context of this study. The primary goal of this study is to understand how effectively the SIVA methodology can be applied to assess an IT system, particularly in comparison to existing methods. The remaining two conditions are satisfied since these events are both contemporary and cannot be controlled by the investigator.

Within case study research, there are different types of case studies. Yin (1984) identifies three major types: exploratory, explanatory, and descriptive.

Exploratory case studies are unique in that fieldwork can precede the development of research questions and measures. Researchers are able to make preliminary observations of the subject and use those observations to develop research questions and measures. Consequently, this approach is useful for preliminary studies that precede more in-depth research (Tellis, 1997).

Descriptive case studies are used to identify hypothetical case-effect relationships. Descriptive studies use a structured description methodology to describe a phenomenon and attempt to draw conclusions from those observations. For example, a descriptive study may compare how several different hospitals operate in terms of technology investment, operational efficiency, and patient care and propose a cause-effect hypothesis based on these three variables. Explanatory case studies investigate causal relationships and therefore, by definition, establish research questions prior to fieldwork.

Of the three types of case studies, this thesis follows the exploratory case study approach where we explore how effectively the SIVA framework can be applied to analyze the value of an IT system. To evaluate effectiveness, we investigates how the SIVA framework compares to ad hoc methods in terms of the three areas it claims to improve upon ad hoc analyses:

I. Understanding What Value Is
II. Understanding How Value Is Created
III. Understanding How Value Can Be Measured

From these three propositions we identify three key research questions:

1. How does the SIVA and ad hoc analyses indicate how value is created?
2. How does the SIVA and ad hoc analyses indicate what value is?
3. How does the measurability of value identified by the SIVA and ad hoc analyses differ?

Note that this study does not claim to fully validate the SIVA framework nor its propositions. Formal validation of the SIVA framework and its propositions is the subject of future research that is preceded by this study.

The next section describes the research methodology that will be used to answer these questions.

4.2 Research Methodology

The fundamental structure of the study is a comparison between an ad hoc value analysis and a SIVA analysis of the same IT system deployment. By comparing both types of analyses for a single IT deployment, this approach stands to reveal significant insight into the differences between a SIVA and ad hoc value analysis.

The ad hoc analysis used in this comparison is an actual value assessment performed by a professional organization to justify, and later analyze, the deployment of a strategically important IT system. This analysis was performed independently of this study and occurred prior to the creation of this study. The results of the ad hoc analysis were collected using field work, through interviews with individuals who manage the IT system and documents created during the ad hoc analysis.

The SIVA analysis is a hypothetical application of the SIVA framework to the same IT system. This application was a joint effort between the author and professional staff who manage the IT system under analysis. In particular, the professional staff provided significant input and validation to the process flow, information audit, and stakeholder value models that underpins the SIVA analysis.

To compare the two analyses, we compare the set of expected impacts and value identified by each analysis. Insight into the validity of the SIVA framework and its propositions will be interpreted from the difference between these two sets of results. The following chapter presents the results from the ad hoc and SIVA analyses. Chapter 6 compares the results from the two analyses and interprets their significance with respected to the research questions of this study.

One major limitation of this comparison is the lack of independence between these two analyses. Due to resource limitations, the fieldwork to collect the results of the ad hoc analysis and the SIVA analysis were performed concurrently, enabling observations from the ad hoc analysis to potentially influence the SIVA analysis. The potential dependency between these two analyses limits what can be interpreted from the framework comparison and is discussed in Chapter 6.

4.3 Summary

This chapter defined the research methodology that will be used to study the SIVA framework. The primary research objective is to investigate whether the SIVA framework can be applied to assess an IT system and if so, how effective it is. To investigate effectiveness, our study attempts to answer the following three questions:

1. How does the SIVA and ad hoc analyses indicate how value is created?
2. How does the SIVA and ad hoc analyses indicate what value is?
3. How does the measurability of value identified by the SIVA and ad hoc analyses differ?

To answer these questions, the research methodology compares the results of an ad hoc analysis with the results of a SIVA analysis for the same IT system deployment. The next chapter presents the results of both analyses. Chapter 6 will examine the difference between the two sets of results and interpret its significance with respect to the original research questions.

Chapter 5:
Case Study

To investigate the validity of the SIVA framework, Chapter 4 defined a comparison based research strategy that compares the results of an actual IT value assessment to a SIVA analysis of the same IT system. This chapter addresses the first portion of the research strategy by presenting the results of both analyses.

The IT system being examined is a patient web portal that was deployed in a hospital organization. The purpose of the patient portal is to provide information to patients undergoing cancer treatment. Through this system, patients are able to track symptoms, fill prescriptions, view personal treatment plan, review treatment history, schedule upcoming appointments, interact with other patients, maintain a personal diary, and access third party cancer resources.

The scope of this comparison is limited to the patient perspective of value for the patient portal. While it is possible to consider how other stakeholders, such as doctors and hospital management value the patient portal, the restriction allows the analyses to focus on the primary audience of the patient portal and allows the SIVA analysis to remain within a reasonable size.

The remainder of this chapter is partitioned into two parts. The first part describes the results of the ad hoc analysis performed on the patient portal. This portion of the study was gathered through interviews with hospital staff and reviewing documents that were created during the deployment of the IT system. The second part of this chapter presents the SIVA analysis of the patient portal that was developed in conjunction with staff involved with the patient portal. This portion of the study was developed through a series of meetings with hospital staff. See Appendix A for more details on the development of the SIVA analysis.

5.1 Ad hoc Value Analysis

The ad hoc value analysis for the patient portal was performed prior to system deployment to justify its inception. To consider the implications of the patient portal from different perspectives, the analysis was performed by a multi-disciplinary team that included both hospital administration and clinical staff. Based on the functionality of the patient portal, the team identified three main value propositions for the system:

- Improving patient outcomes and experience
- Improving organizational efficiencies within the hospital
- Increasing hospital revenue from online pharmacy sales

To remain within the scope of this study, we focus on how the patient portal was expected to improve patient outcomes and experience.

The results of the ad hoc analysis were collected through meetings with hospital staff and documents created during the ad hoc analysis. Based on our observations, the ad hoc analysis identified the following as possible implications of deploying the patient portal:

- Improved patient learning
- Patients making more informed choices regarding treatment

- Improved patient emotional support
- Increased patient perception of control
- Improved treatment compliance
- Earlier identification of side effects
- Improved patient outcomes

The multi-disciplinary team identified patient education as one of the key areas that would likely be affected by the patient portal. Traditionally, the information provided by the patient portal was typically conveyed during consultations at the hospital. By providing these information resources through a constantly accessible online portal, patients would be able to review treatment related information at any time, at their pace, and with their family; ultimately improving their absorption of treatment related information. The team also identified other areas that could potentially be affected by gains in patient education. This included patients being able to make more informed treatment decisions, patients perceiving greater control over their treatment, and patients being more compliant with their treatment instructions. The team also linked greater patient perception of control with greater patient confidence in treatment, citing improved patient emotional health as another potential impact of the patient portal. The symptom reporting facilities provided by the patient portal were also noted to potentially enable earlier identification of side effects. The culmination of these potential implications suggested that the patient portal stood to improve both the patient experience and patient outcomes.

After the patient portal was deployed, anecdotal feedback from patients indicated that some of the forecasted impacts were being realized. This feedback indicated that patients valued the patient portal in multiple ways. Some patients valued the portal as a scheduling tool, making it more convenient to track and schedule appointments with their care providers. Other patients valued the portal as a learning tool that made it easier to understand the stages of cancer therapy and the associated side effects. The portal was also perceived as a valuable communication tool that made it easier to report side effects in a format that care providers can accurately interpret. In addition to these benefits, patient feedback also indicated that the portal provided personal emotional value. Some patients indicated that they using the portal made them feel more in control of their treatment process and helped them share their treatment experience with friends and family members.

However, beyond these anecdotal testimonials, quantitative evidence to support the forecasted portal impacts could not be observed at the time of this study. Although attempts were made to measure how the portal affects certain aspects of treatment, such as patient acuity upon admission and length of consultation times, this data was heavily affected by existing processes within the hospital that prevented the collection of meaningful data. For example, in attempts to measure the length of patient consultations, different procedures for recording patient check-in and check-out times prevented the collection of meaningful data. Recognizing that current metrics did not adequately convey the value of the patient portal, the hospital plans to revise its practices to support the development of treatment related metrics.

In summary, this section presented the primary findings of the ad hoc analysis and the subsequent developments of the patient portal. Based on these findings, we can observe anecdotal indicators that suggest the portal was valued by patients based on a variety of criteria, such as education, communication, and emotional health. More over, we observed that attempts to measure value were hampered by operational factors that clouded the collection of meaningful data. The next section reexamines the patient portal using the SIVA analysis framework.

5.2 SIVA Value Analysis

The SIVA value analysis presented in this section is a hypothetical application of the SIVA framework to the patient portal described in the ad hoc analysis. Based on input from hospital staff involved with the patient portal, we present the process flow, information audit, and stakeholder value models specific to this IT system deployment. Using these models, the latter part of this section presents a hypothetical value analysis of the patient portal.

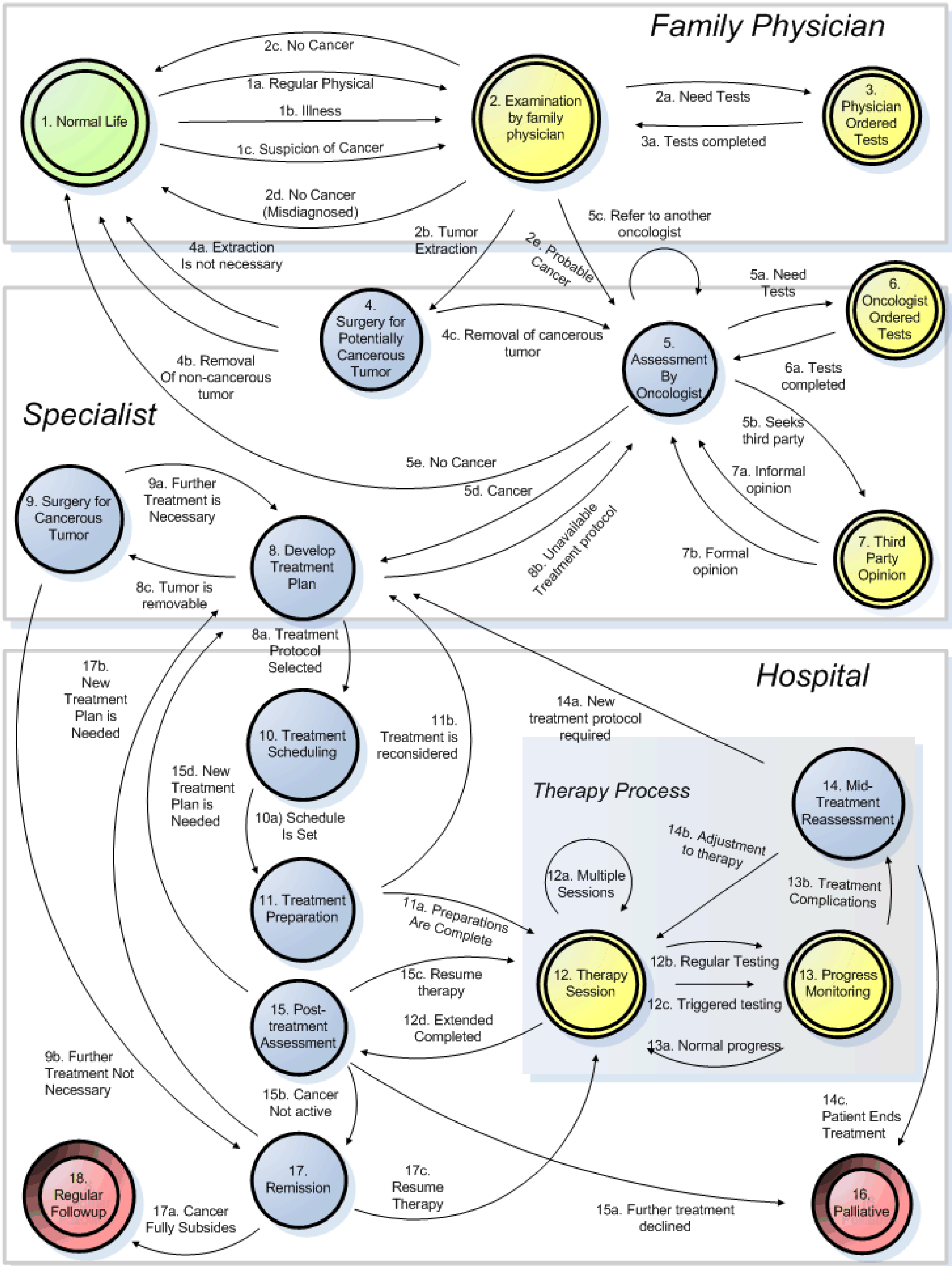
The SIVA analysis framework is underpinned by three models:

- Process Flow model
- Information Audit model
- Stakeholder Value model

5.2.1 Process Flow Model

The purpose of the process flow model is to describe the deployment environment of the IT system in terms of tasks. Since the patient portal is targeted specifically for cancer patients, we consider the deployment environment to be the entire cancer treatment process. Figure 7 illustrates how the cancer treatment process can be organized into a network of interrelated tasks.

Figure 7. Cancer Treatment Process



The tasks span the entire cancer treatment process, from before cancer is diagnosed to after treatment is completed. Within this broad scope of tasks, there are three main groupings: physician, specialist, and hospital. The physician group of tasks encompasses the early stages of cancer treatment where the patient first discovers that they have cancer through their family physician. The specialist group of tasks encompasses the next stage of cancer treatment where the oncologist determines the severity of the cancer and works with the patient to determine a course of treatment. The hospital group of tasks encompasses the remainder of the cancer treatment process, where the treatment plan is implemented and the patient's response to therapy is monitored.

A patient's cancer treatment experience can be described as a sequence of transitions between the states in the process flow model. For example, a patient may start off leading a normal life (Stage 1) and see their family physician for a regular cancer check-up (Stage 2). During the regular cancer check-up, the physician may notice cancer symptoms and run preliminary tests to investigate for the presence of cancer (Stage 3). If the preliminary tests are positive, the patient will see an oncologist for a full assessment (Stage 5) who will run further tests to determine the severity of the cancer (Stage 6). If the presence and severity of the cancer is confirmed, the patient will consult the oncologist to determine the appropriate form of treatment (Stage 8) and schedule the corresponding therapy sessions (Stage 10). The patient will then undergo preparatory tests for therapy (Stage 11) and then begin their therapy sessions (Stage 12). The patient may undergo multiple iterations of therapy (Stage 12) and progress monitoring (Stage 13) until their mid-treatment assessment (Stage 14) where treatment parameters may be adjusted before undergoing further iterations of therapy (Stage 12) until the treatment plan is completed. After treatment is completed, the patient undergoes a post treatment assessment (Stage 15) where the cancer is no longer active and goes into remission (Stage 17). Once the cancer fully subsides, the patient continues regular follow-up sessions (Stage 18) catch any subsequent relapses. This examples, illustrates just one of many paths in the process flow model that a patient may take when undergoing cancer treatment.

5.2.2 Information Audit Model

The information audit model augments the process flow model by describing the information inputs and outputs of each task within the flow model. For each task in the cancer treatment process, the information audit model identifies the information inputs used by the task and information outputs that result from performing the task. Additionally, the user, purpose, frequency, and transmission issues of the information inputs are also identified. An example of an information audit for the monitoring progress task is illustrated in Table 6 and Table 7.

Table 6. Information Inputs and Outputs

Inputs	Outputs
• Treatment precautions • Patient/family observed symptoms* • Treatment schedule • Previous test results • Current test results	• Need for treatment modification • Archived test and assessment results

Table 7. Information Usage

Information	User	Purpose	Frequency	Trans. Issues
Treatment precautions	*Patient/ Family*	*Identifies the important symptoms to look for in this treatment protocol*	*Depends on patient involvement.*	*Forget, disregard*
Patient/family observed symptoms	*Medical staff*	*Identify treatment complications*	*Often*	*Over and under reporting of symptoms*
Treatment schedule	*Patient/ Family*	*Determine appointment times.*	*Depends on stage of treatment, treatment progress, in/out patient status*	*Changes in patient needs cause rescheduling*
Current Test results	*Medical staff*	*Identify treatment complications*	*Always*	*None*
Previous test results	*Medical staff*	*Compared against current results to monitor impact of treatment*	*Always*	*None*

The progress monitoring task is performed between cancer therapy sessions to monitor how the patient is responding to therapy. Table 6 identifies the information inputs used to monitor a patients progress and the information outputs that are produced by monitoring a patient's progress. The information outputs include an indicator of whether the treatment plan needs to be altered and tests results that will be archived for comparison to future tests. The information outputs are presented in greater detail in Table 7. The first row the table indicates that a patient or family member may need to recall treatment precautions to identify what symptoms are indicative of adverse therapy reactions. These indicators can be forgotten or disregarded, which can lead to further complications if left undetected. The second row of the table indicates that medical staff will often ask patient and family member about observed symptoms to identify any adverse reactions to treatment. This symptom information can be potentially inaccurate in a variety of ways such as over reported or under reported. In addition to information inputs, performing the progress monitoring task can also produce information outputs for other tasks. As indicated in Table 6, the progress monitoring task may indicate the need to change a patient's treatment plan or produce test results that will be used for future reference.

Performing the information audit for each task in deployment environment reveals a new perspective of the cancer treatment process. Each task can be seen in terms of an actual activity and an information processor. The SIVA framework leverages both of these perspectives when considering the impact of the patient portal. Appendix A presents the information audit for all of the tasks in the cancer treatment process.

5.2.3 Stakeholder Value Model

The first two models focused on describing the cancer treatment process in terms of tasks and information flows. The stakeholder value model focuses on identifying what value means to a cancer patient. Through examining how each of the intended impacts of the patient portal benefited patients and taking into account why patients found the patient portal useful, we construct a stakeholder value model that consists of four value dimensions:

- Physical health
- Emotional health
- Personal life
- Health process

From interviews with hospital staff, we selected these four dimensions based on our understanding of how patients interacted with the patient portal. These dimensions represent what the SIVA analysis presumes to be the different ways in which patients may value the patient portal. The physical health dimension reflects how patients may find something valuable if it improves their physical well being. The emotional health dimension reflects how patients may find something valuable if it improves their emotion condition. The personal life dimension reflects patient value in terms of how it affects their relationship with friends and family members. And the health process dimension reflects patient value in terms of how it affects the provision of medical care to patients. It is important to note how these value dimensions are independent from one another. An IT system can be valuable to in terms of improving the provision of medical care, even if the patient is in poor physical health. Similarly, an IT system can be valuable in terms of its impact on patient emotions, even if it has negligible clinical impact. As a result, we select these four dimensions to represent the different ways in which the portal may be valuable.

These four value dimensions were constructed based on the observations from the ad hoc analysis. Each of the potential impacts identified in the ad hoc analysis can be linked to one or more of these four value dimensions. For example, through improving patient education, the ad hoc analysis identified multiple second and third order impacts linked to the emotional health (perception of control; informed patient decisions; confidence in treatment), health process (compliance with treatment, informed patient decisions), and physical health (aggregate of previous impacts). Similarly, the anecdotal patient testimonials observed in the ad hoc analysis can also be linked to the four value dimensions. These testimonials identified value with respect to the health process (using the portal as a scheduling tool; side effects reporting) and personal life (sharing treatment experience with others).

Such a definition of value provides a frame of reference from which the value of an IT system can be assessed. The SIVA analysis framework first iterates through the process flow and information audit models to understand how the patient portal changes the cancer treatment process. The follow stage examines value of the patient portal through systematically analyzing how each of those changes affect each of the four value dimensions. Using this analysis methodology, a hypothetical value assessment of the patient portal is presented in the following section.

5.2.4 Application of SIVA Framework

This section describes a limited application of the SIVA framework to understand how patients may value the patient portal. The first stage of this analysis involves understanding how the cancer treatment process may change as a result of deploying the patient portal. Operationally, this involves iterating through each of the tasks in the process flow model and identifying how the task and its associated information flows may change due to portal usage. For example, at the Oncologist Assessment task in the process flow model, the patient portal may enable patients to research cancer therapy prior to the assessment.

The next stage of the analysis involves understanding how changes to the cancer treatment process may be significant to patients. Operationally, this involves examining the significance of each change with respect to the value dimensions that define the stakeholder value model. For example, enabling patients to research cancer therapy prior to the oncologist's assessment may be significant to from a health process perspective because it may affect how patients communicate with the oncologist during the assessment.

Table 8 illustrates how the two stages of analysis can be applied to the entire cancer treatment process. The first stage of understanding how the patient portal changes the cancer treatment process is summarized in task and impact columns of Table 8. The task column identifies the cancer treatment tasks that can be potentially impacted by the patient portal. The impact column describes what those impacts are. Entries in the task and impact columns are obtained from iterating through the process flow model and considering how each task and its associated information flow is affected by the patient portal. For example, consider the oncologist assessment task that occurs after a patient is diagnosed with cancer. The provision of the patient portal can affect this task in a number of ways. Through the educational resources provided by the portal, one possible impact is that patients are able to access cancer treatment materials specific to their care provider prior to their oncologist's assessment. Through the forums provided by the portal, another possible impact is that patients are able to connect with other patients with the same disease while they wait for appointment with the oncologist. Leveraging the treatment history functionality of the portal, another possible impact is that patients are able to show the results of the assessment to friends and family members through their computer at home. This impact analysis is repeated for each task in the cancer treatment process and their results are summarized in the task and impact columns of Table 8.

The significance of these impacts to patient value is summarized in the dimension and value columns of Table 8. The dimension column identifies the patient value dimensions that may be affected by a given impact while the value column explains how the value dimension is affected. This stage of the analysis involves iterating through the impacts identified in the previous stage and determining how they affect the physical health, emotional health, health process, and personal life dimensions from the stakeholder value model. For example, consider an impact to the oncologist assessment task may be significant to the health process dimension. Enabling patients to research cancer therapy more effectively, prior to the assessment, can be valuable to patients because it can affect their ability to communicate with the oncologist during the assessment. Additionally, this impact allows patients to interact with their care provider at an earlier stage of the treatment process. This also illustrates the necessity to drill down on any initial impact to discover secondary or tertiary impacts. These less immediate impacts may have more substantial value and impact than the original triggering impact. Understanding the context and applying the dimensional analysis associated with SIVA is useful for identifying and isolating these additional impacts.

We can also consider impacts to the oncologist assessment task with respect to the emotional health dimension of patient value. At this stage of treatment, where patients have just been diagnosed with cancer and are in the process of transforming their lifestyle to accommodate treatment, enabling patients to connect with other patients may help patients find peer support during this time of radical change. This value analysis is repeated for each of the impacts identified in the previous stage and is summarizes in the dimension and value columns of Table 8.

Table 8. Application of the SIVA Framework

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Value	Dimension	Impact	Task
Improved communication during oncologist assessment	Health Process	Research prior to oncologist assessment	Oncologist Assessment (before)
Including hospital in at earlier point	Health Process		
Patients have access to a peer support group	Emotional health	Connect with patients prior to oncologist assessment	
Involve family members in treatment process (even those afar)	Home	Ability to let others view assessment details	Oncologist Assessment (after)
Make more informed choices regarding treatment selection	Health Process	Patients can educate themselves about treatment	Develop Treatment Plan (before)
Understanding treatment selection improves confidence in treatment	Emotional		
Understanding treatment selection improves perception of control	Emotional		
Ability to review the plan that may save their life	Emotional	Patients can access selected treatment plan through the portal	Develop Treatment Plan (after)
Patients can familiarize themselves with the treatment process	Health Process		
Encourage patients to be more engaged in their treatment	Health Process		
Peer level support for treatment plan	Emotional	Patients can discuss treatment plan with other patients on the portal	
Allow family members to view what will be happening directly from the care provider	Home	Ability to let others view treatment plan	
Reducing likelihood of rescheduling tests	Health process	Patients can view preparation instructions to avoid slowing down or delaying tests	Treatment Preparation
Get treatment underway sooner	Physical Health		
Helps family coordinate activities around the patient's treatment plan	Home	Patients can access appointment schedule through the portal and share it with family members	
Patients feel less anxiety because they understand the process	Emotional	Patients can review therapy procedure through the patient portal	Therapy Session (before)
Patient knowledge of therapy process allows therapy to proceed more smoothly	Health Process		
Patient feels more comfortable about process after talking to somebody who has been through it	Emotional	Patients can talk to other patients about a particular therapy	
Provides a history of symptoms experienced by the patient	Health Process	Patients can record the symptoms they are experiencing	Progress Monitoring
Encourages patients to be more proactive with their treatment	Health Process		

Allows family members to help keep track of the patients symptoms	Home		
Helps identify treatment complications earlier	Physical Health	Patients are able to report symptoms from home immediately after experience them.	
Improves overall completeness and accuracy of symptom reports from patients	Health Process	Patients are able to report symptoms through standardized forms	
Helps monitor overall patient recovery and identify potential relapses	Physical Health	Patients are able to report symptoms as they continue on with their life	Regular Follow-up

5.3 Summary

This chapter presented the results of the SIVA and ad hoc analyses of the patient portal. The results of the ad hoc analysis were collected through fieldwork from a value assessment used to justify the deployment of the patient portal. The results of the SIVA analysis were generated through a hypothetical application of the SIVA framework assisted by hospital staff. The following chapter compares the results from these two analyses and uses this comparison to draw insights into the research questions regarding the SIVA framework.

Chapter 6:

Analysis and Discussion

The case study in Chapter 5 presented the results of two different value assessments of a patient web portal for cancer treatment. The first assessment was an ad hoc value assessment done by hospital staff to initially justify the expenditure of the patient portal system. The second assessment was a hypothetical application of the SIVA framework to the same IT system deployment. This chapter compares the results of the two analyses to investigate the propositions of the SIVA framework that claim improvements over ad hoc assessment methods with respect to:

1. Providing insight into the meaning of value
2. Providing insight into how an IT system is utilized
3. Providing insight into how IT value can be measured

The objective of this comparison is to investigate the viability of the SIVA framework as an alternative to common industry practice for assessing the value of IT systems. Because this study compares the SIVA framework with only one value analysis from industry, this study cannot provide any meaningful validation of the concepts of the SIVA framework. Instead, this is an exploratory study that focuses on seeking evidence to support the ideas proposed by the SIVA framework. If this comparison can demonstrate the benefits claimed by the SIVA framework over industry practice, then this study will merit further research work in validating the SIVA framework.

6.1 Insight into the Meaning of Value

The first proposition of the SIVA framework claims that a SIVA analysis provides significantly more insight into why stakeholders find an IT system useful than typical ad hoc analyses. To investigate this claim, we compare how the ad hoc and SIVA analyses describe how patients may find the patient portal valuable.

Based on the knowledge and experience of hospital staff, the ad hoc analysis identified a number desirable outcomes that may result from using the patient portal. These outcomes included improvements in patient learning, decision making, emotional support, perception of control, treatment compliance, side effects reporting, and overall patient outcomes. While significant attention was given to identifying useful outcomes of deploying the patient portal, as a value analysis, the ad hoc analysis lacks two major components: (1) a clear definition of what value means and (2) explanations for why each of the identified outcomes are valuable.

The first limitation of the ad hoc analysis is that it fails to first establish what value means in the assessment. Based on the definition of value established in Chapter 1, value is a relative concept depending on the perspective from which it is being assessed. A single outcome can be simultaneously valuable to one stakeholder while worthless to another. Thus for a the set of outcomes identified by the ad hoc analysis, it necessary to consider from what stakeholder perspectives are these outcomes identified as valuable. Moreover, what assumptions about stakeholder perceptions of value are being made when identifying this set of outcomes? The ad hoc analysis does not address these issues and consequently provides no defendable basis for why the identified set of outcomes are identified as valuable.

The second limitation of the ad hoc analysis is that it does not explain how each of the identified outcomes are valuable. The outcomes identified by the ad hoc analysis can be valuable to different stakeholders in different ways. For example, consider increased patient perception of control which was identified as a value by the ad hoc analysis. Patients may find increased perception of control valuable because it improves their emotional state while physicians may find it detrimental because it makes patient interaction more difficult. Even for a single stakeholder, an outcome can be valued in different ways. For example, patients may also value increased perception of control because it increases their level of confidence in treatment or allows them to interact with care providers on their own terms. These examples serve to illustrate how a single outcome of using an IT system, such as increased patient perception of control, can be beneficial or detrimental in multiple ways to multiple stakeholders. By omitting such information, the ad hoc analysis partially explains how using the portal is significant to various stakeholders.

The systematic methodology prescribed by the SIVA framework addresses these limitations of the ad hoc analysis. Using stakeholder value models, the SIVA framework explicitly defines what value means in terms of different stakeholders and presumptions of what they find valuable. For this case study, the SIVA analysis defines a stakeholder value model for cancer patients, calling out four assumptions of what patients perceive as valuable. These four assumptions are that patients will perceive something as valuable if it (1) improves their physical health, (2) improves their emotional health, (3) improves their ability to receive medical care, and (4) improves their lifestyle at home. The SIVA analysis uses these assumptions of value as a basis from which to evaluate if and why the portal is valuable to cancer patients.

The resulting value analysis differs dramatically from the results of the ad hoc value analysis. In particular, both the number and detail level of values identified by the SIVA analysis in Table 8 significantly exceed those of the ad hoc analysis. For example, while the ad hoc analysis suggests that the portal may improve patient learning, the SIVA analysis identifies the various instances of patient learning being valuable to patients. One such instance is how patients may be able to communicate more effectively with their oncologist if they research cancer therapy through the portal beforehand. Another instance is the reassurance patients may receive from using the portal to review their treatment plan after selecting it. Similarly, while the ad hoc analysis suggests that the portal may provide patient emotional support, the SIVA analysis identifies specific examples of this such as patients using the portal to obtain peer support from other cancer victims upon being diagnosed with cancer and as they endure the effects of therapy.

Despite these significant differences, very little can be claimed about the additional value insights claimed by the SIVA framework over typical ad hoc value analyses. The primary significance of this comparison is that it demonstrates one instance where the value insights formed using the SIVA methodology map closely and in some cases exceeds the value insights identified by a value assessment used to justify a major IT system expenditure at a large organization. From this instance, we can interpret that a SIVA analysis can potentially provide more value insight than traditional value assessment methods. However, the validation of this potential is the subject of future research.

6.2 Insight into how an IT System is Utilized

The second proposition of the SIVA framework claims that SIVA based analyses provide more insight into how an IT system is utilized to create value than typical ad hoc analyses. To investigate this claim we compare how the SIVA and ad hoc analyses describe the anticipated usage behaviours of the patient portal.

Our observations of the ad hoc analysis indicated that the value analysis team anticipated two primary uses of the patient portal: patients using the portal to learn about treatment and patients using the portal to report side effects. From these two anticipated usage behaviours, a number of likely outcomes were identified. For patients using the portal to learn about therapy, these outcomes included the ability to make more informed choices regarding treatment, increased emotional support, greater compliance with treatment instructions, and increased patient perception of control. For patients using the portal to report side effects, these outcomes included improved patient-physician communication and more timely identification of treatment side effects.

In comparison, the SIVA analysis analyzes portal usage behaviours at a significantly more detailed level by describing different contexts in which the patient portal is used. These contexts are derived from the process flow and information audit models of SIVA analysis. The process flow diagram describes the various stages of the cancer treatment process, identifying the different temporal contexts where the portal may be used. The information audit model identifies different information contexts by describing the different pieces of information used throughout the cancer treatment process. These models are used to identify different usage contexts of the patient portal. As a tool to help patients learn about treatment, the SIVA analysis identifies a number of temporal contexts within cancer treatment such as prior to an oncologist's initial assessment, after the oncologist's assessment, during therapy, after therapy, and so forth. The SIVA analysis further analyzes these contexts in terms of the information used throughout the cancer treatment process. For example, the SIVA analysis suggests that patients may be interested in learning general information about their disease prior to being assessed by an oncologist, specific details about their diagnosis after their assessment, specific treatment guidelines while undergoing cancer therapy, and guidelines on regular monitoring after therapy is complete. Moreover, these contexts are used to expand upon the values originally identified in the ad hoc analysis. For example, while the ad hoc analysis identified that patients may use the portal to report side effects, the SIVA analysis expands upon this in terms of time and information, such as during therapy, where a certain set of symptoms are monitored to indicate the patient's response to therapy and after therapy where a different set of symptoms may monitored to indicate any resurgence of cancer.

With respect to providing insight into how an IT system is used, this comparison suggests that the SIVA analysis does indeed provide greater insight into how an IT system is used. In particular, the SIVA analysis uses its underlying two models to examine how IT system usage changes over time and across different types of information. As a result, the analysis produced a significantly more detailed picture of how patients may use the portal relative to the ad hoc value analysis. However, it is important to recognize that many questions remain. Should usage be viewed in contexts other than time and information? Do these results generalize across other IT system deployments? These are questions that need to be addressed in order to make any significant claims regarding the second proposition of the SIVA framework.

6.3 Insight into how Value can be Measured

The last proposition of the SIVA framework claims that a SIVA analysis provides more insight into measuring the value of an IT system than typical ad hoc analyses. To investigate this proposition, we identify the value measurement issues observed in the ad hoc analysis and examine how or if these issues are addressed by the SIVA analysis.

In preliminary efforts to measure the value of the patient portal, one of the primary issues encountered by the hospital was the difficulty of creating metrics that could accommodate the variation of practices within the hospital. Certain processes, such recording patient check-in and check-out times, were performed differently based on a variety of factors, making it difficult to gather meaningful data from simple metrics such measuring the length of patient consultations. This reflects the importance of understanding the process context when developing metrics to gather data. Different entry points, exit points, and exceptions within a given process introduce variables that may need to be accounted for when developing metrics. The process flow model in the SIVA framework contributes to the identification of such variables by identifying the relationships between various processes. To illustrate how different process entry points can affect a metric, consider how a metric for patient learning during oncologist consultations may exhibit different data patterns depending on where the patient is coming from. Patients coming in for their initial consultation who have never been through cancer treatment may exhibit different learning patterns than a patient who is coming in midway through therapy. This also applies to process exit points such a patient satisfaction metric at the end of therapy, where satisfaction with treatment may vary according to whether the patient goes into remission (treatment is successful) or palliative care (treatment is not successful).

Another major issue we observed from the case study was the identification of what should be measured to convey the value of the patient portal. While patient testimonials and the intuition of hospital staff suggested that the patient portal provided significant value to patients, the hospital staff found that existing portal metrics did not effectively convey this and were actively seeking to identify and develop metrics for the patient portal. In essence, they were trying to convey a sense of how valuable the portal is in a more objective manner than anecdotal patient testimonials. In light of this limitation identified by hospital staff, we can observe three ways in which the SIVA analysis aids in the development to value metrics.

As it is necessary to define something before it can be measured, the first contribution of the SIVA analysis is the greater insight it provides into the meaning of value. The initial survey metrics for the patient portal focussed on how often patients used the portal and what they found useful about the portal. However, the survey did not establish what useful meant nor why patients found things useful. As a result, very little could be measured beyond system usage. In section 6.1 we noted that unlike the ad hoc analysis that the survey was based upon, the SIVA analysis explicitly defines what is assumed to be valuable to patients and systematically identifies how using the portal is expected to affect those value assumptions. This insight identifies a significantly richer set of metrics that measure not only usage, but various stakeholder perceptions and how certain usage behaviours affect those perceptions.

The second contribution of the SIVA framework is the contextual awareness of how value can be realized differently throughout the cancer treatment process. The process flow model introduces a temporal aspect of how different types of value are realized at different stages of the cancer treatment process. The information audit model introduces a information context where value is realized differently based on the characteristics of information being used. Such contexts can be leverage in the development of metrics. For example, metrics for patient learning can be deployed at various stages of the cancer treatment process, such as before therapy, during therapy, and after therapy. Patient learning metrics can also be tailored for different information contexts, such as patients with a positive or negative prognosis. In essence, these contexts identify different locations where value metrics can be deployed. By examining where metrics are currently placed within all of the possible value contexts, it is possible to get a sense of what value is being caught by metrics and what value is being overlooked.

The third contribution of the SIVA framework is how the foundation of a SIVA analysis can be validated and maintained. When the SIVA framework is used to analyze the value of an IT system, the underlying models of the SIVA analysis define the assumptions of the value analysis. The stakeholder value models define what assessors presume to be valuable to each stakeholder. The process flow and information audit models define what the assessors presume to be the deployment environment of the IT system under analysis. These models are then utilized by the SIVA methodology to identify possible forms of value that may result from using the IT system under analysis. The systematic methodology in which this is done allows identified forms of value to be traced back to its originating usage context and underlying value motivation. For example, the SIVA analysis in Table 8 identifies that the patient portal may be valuable because it encourages patients to be more involved in the treatment process. From the "Dimension", "Impact", and "Task" columns of Table 8, the basis for this value is the presumption that patients find it valuable to be involved in their treatment process and that the patient portal enables patients to review the details of their treatment protocol after it is selected. The preservation of this linkage allows values identified by the SIVA analysis to be validated by verifying their underlying presumptions. Moreover, as stakeholder values and the usage environments change over time, a SIVA analysis can be rerun on updated models to understand how value changes over time.

In summary, with respect to aiding in the measurement of value, we observed a number of properties of the SIVA analysis that directly address the measurement limitations found in the ad hoc analysis. To address the challenges observed in developing robust metrics, we discussed how the process flow and information audit models of the SIVA framework can aid in identifying different cases that metrics must accommodate. To address the challenges in determining how value should be measured, we discussed how the SIVA framework can aid in defining, deploying, and maintaining value metrics. However, it is important to recognize the speculative nature of these observations. As this study does not implement value metrics based on these observations, all that can be claimed is that this comparison suggests that SIVA framework can aid the development of IT value metrics.

6.4 Discussion

Through this comparison, very little can be claimed about the validity of the SIVA framework and its propositions. This case study is a comparison between an actual value analysis of an IT system and a hypothetical application of the SIVA framework to the same IT system after the fact. Applying the SIVA framework to a single IT system deployment prevents this study from making any general claims regarding the SIVA framework. Additionally, because research work was performed simultaneously on both the SIVA analysis and ad hoc analysis, the potential for dependencies between the analyses exist and limits the relevance of directly comparing the results of the two analyses. However, despite these limitations, the comparison does provide a significant contribution towards studying the SIVA framework.

The primary contribution of this study is that it serves as an existence proof for the SIVA framework. Unlike the original value analysis of the patient portal that identified potential forms of value on an ad hoc basis, the SIVA analysis demonstrated how IT value can be analyzed using a systematic method that can be repeated and validated. Moreover, the study demonstrates that a SIVA based value analysis is capable of achieving a result that is comparable, and possibly superior, to existing value assessment methods in industry and provides circumstantial evidence to support the validity of the SIVA framework.

The secondary contribution of this study is the suggestion of advantages associated with using the SIVA framework as a value analysis tool. While the limitations of this study prevent us from claiming any advantages with using the SIVA framework, comparing the results of the two analyses provides evidence in favour of the three propositions of the SIVA framework that claim benefits with respect to identifying value, understanding IT system usage, and value metric development.

As noted in the introduction, this research is part of a larger research agenda that is in its infancy. A socio-tech framework and theory for understanding the value of IT is being developed and there are three areas being probed prior to the next step of theory development. The basic ability to describe and decompose the in situ value and temporal variants has been probed in a very preliminary way by McKay and Ng (2004). The ability to systematically assess value using the principles underpinning the framework was probed in this thesis. The ability to design according to the value criteria has yet to be probed.

Assessing value required the integration of three concepts: the conceptualization of the process model, information audit at each point in the process model, and a value description model. The latter being derived from McKay (2004). The previous McKay (2004) and McKay and Ng (2004) work did not address assessment specifically and did not probe the use of general assessment theories. The research reported in this theory demonstrates that such a marriage of models and concepts is possible and that a systematic methodology is also possible. This is the limit of the claims and contributions of this thesis. The research on value assessment is a key component of understanding the socio-technical aspects of the value equation and extends the basic understanding in this dimension.

Chapter 7:
Conclusion

In Chapter 1, we introduced how this thesis fits into a broader research agenda to develop a general framework for IT value. To this end, this thesis serves as an existence proof for the assessment component of this broader research effort.

We began by discussing the multi-dimensional nature of value and suggested a number of different perspectives to view the value of an IT system. Other IT assessment frameworks in the literature (Davis & Venkatesh, 2000; Rogers, 1995; DeLone & McLean, 1992; Grover et al., 1996; Seddon et al., 1999) have also observed the multi-dimensionality of value and proposed various dichotomies to organize these value dimensions. Comparing these IT assessment frameworks identified two major shortcomings with IT assessment literature: (1) the fragmented definitions of value across different frameworks and (2) the universal lack of methodology to operationalize any of the IT assessment frameworks on an actual IT system deployment.

The SIVA framework proposed in this thesis is an IT value assessment framework that attempts to overcome these shortcomings. Bridging the multi-dimensional value concepts of McKay and Ng (2004) and the business process measurement concepts of Camp (1995), the SIVA framework proposes a systematic methodology to analyze IT value based on explicit models of stakeholder value, IT system usage, and information usage. More specifically, it was conceived as an analysis tool to help assessors identify potential value that may result from using a given IT system.

A case study was used to investigate the validity of the SIVA framework. The SIVA framework was hypothetically applied to a major IT system deployment in the medical field and the results of the analysis were compared to the original value analysis used to justify the IT system. Through this comparison, the SIVA analysis provided significantly more insight into value than the original ad hoc analysis. While the limitations of this study prevent us from making any claims regarding the SIVA framework, a number of significant observations were revealed through this comparison. The primary observation from this exercise is simply the demonstration that it is possible to use the SIVA framework to analyze the value of an IT system. Moreover, comparing the results of the SIVA analysis with an actual value analysis from industry suggest potential benefits from using the SIVA framework.

All that can be claimed through this study is that we have demonstrated the potential viability of the SIVA framework as an IT value assessment tool. Significant research work remains as the SIVA framework is but a small part of a larger research agenda for a broad IT value framework to define, assess, and refine IT value. The work of McKay and Ng (2004) provided existential support for a general framework to define IT value. This thesis provides basic existential support for a general framework to assess IT value. A general method to design IT for optimal value based value metrics has yet to be probed. For the SIVA framework in particular, this study leaves many gaps that need to be addressed in future research. Key areas include investigating the applicability of the SIVA framework to different IT system deployments and to gauge the relative advantages (and disadvantages) of using the SIVA framework over other IT value assessment methods. Despite these limitations however, this study reamins significant in that it demonstrates the potential of a significantly more prescriptive approach to IT value assessment than what currently exists in the literature and highlights potentials advantages of such an approach over existing industry practice.

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Appendix A

SIVA Analysis Details

The SIVA analysis performed in the case study portion of this thesis was performed in conjunction with hospital staff involved with the patient portal system. Throughout the course of the study, a number of meetings were held with the project director of the patient portal system. This appendix discusses the process that was taken to collect the findings of the case study.

The initial meetings with the project director were focused on obtaining background on the patient portal. During these meetings, we discussed the motivation for the patient portal, how it was implemented, patient feedback on the system, and the challenges involved in assessing the value of the patient portal. The information gathered during this phase provided foundational knowledge to guide the construction of sub-models for the SIVA analysis.

The next stage of our research was the creation of the process flow model to understand the cancer treatment process. The final model is presented in Figure 6 and Figure 7 in the body of this thesis. The initial model was created based on discussions from the initial meetings with the project director. The process flow model was then reviewed by the project director, leading to revisions that produced the final process flow model presented in this thesis.

After the process flow model was complete, our focus turned to developing the stakeholder value and information audit models for the SIVA analysis. Again, based on previous discussions, a preliminary stakeholder value and information audit models were created and submitted to the project director for review. The models were then revised based on collected feedback, leading to the patient value dimensions presented in 5.2.3 of the thesis body and the information audit model presented in this appendix. For each stage of the process flow model, the information audit model describes the activities that occur during that stage, the information inputs and output of that stage, and how information inputs are used during that stage.

After creating the sub-models of the SIVA analysis with the guidance of hospital staff, the last stage of the research was to apply the SIVA analysis methodology to the patient portal and compare the resulting insights about value with the original value analysis used to justify the patient portal.

To collect information regarding the original value analysis, a structured interview was held with the project director of the patient portal regarding the original motivations and inception of the patient portal. Additionally, we reviewed hospital documents and presentations used to justify the patient portal for further insight. This data is was utilized to form the ad hoc potion of case study presented in the thesis body. The SIVA methodology was then hypothetically applied to the models constructed earlier, leading the value insights of the patient portal presented in Table 8 of the thesis body. Additionally, the process flow, information audit, and stakeholder value models that underpinned the value analysis are presented in 5.2.1, 5.2.2 and 5.2.3 of the thesis body respectively.

Information Audit Model

This sub-section describes the flow of information between the various stages of the cancer treatment process. For each stage of the cancer treatment process, the information audit model describes what occurs during the stage, the information inputs and outputs to the stage, and how information inputs may be used during the stage.

1. Normal Life

1.1 Description

While the stage seems to encompass a tremendous amount of activities, in the context of cancer treatment, the purpose of the Normal Life stage is to detect cancer symptoms as early as possible.

Detection is initiated in a number of different ways and the duration between emergence of the symptom and actual detection varies widely. The first initiator of detection is by the patient when they have identified developments in their body that suggest the presence of cancer. In some cases, diligent patients will consult their physician at the slightest development in their body resulting in very short durations between emergence and detection. Other patients may ignore symptoms for months and years until these symptoms become noticeable to the patient. Additionally, previous cancer verdicts given by the physician will also influence whether the patient get their symptom looked at. Another initiator of detection is when the patient sees their physician regarding some ailment to then discover it is cancer. While this is nearly identical to the previous initiator, the key distinction is that the patient does not have any preconceived notions of cancer when they see their physician. This distinction can significantly influence both the physician's and patient's behavior in following stages. The last possibility is through regular screenings, where the patient consults their physician on a regular basis for cancer screenings without any symptomatic triggers. Often such screenings are scheduled on an annual basis.

1.2 Information Inputs and Outputs

Inputs	Outputs
• Family History • Cancer inspection guidance (methods and symptoms to look for) • Monitoring schedule • Previous cancer verdicts by physician	• Patient's observations • Patient's preconceptions

1.3 Information Usage

Information	User	Purpose	Frequency	Trans. Issues
Family History	*Patient*	*Provides some guidance on the likelihood of developing cancer*	*People sometimes take this into consideration*	*None*
Cancer Inspection Guidelines	*Patient*	*Used to help patient identify cancer symptoms*	*Rare to sometimes?*	*Often incomplete. Misinterpreted.*
Monitoring Schedule	*Patient*	*Tells the patient when they should go in for cancer screening*	*How many people get regular cancer screening?*	*Patient may forget*
Previous cancer verdicts	*Patient*	*Influences the patient's perception of their symptom or of the physician*	*Sometimes*	*Misinterpreted*

2. Examination by Physician

2.1 Description

The purpose of the stage is for the physician to validate the presence of cancer in the patient.

Once the patient is triggered to see a physician in the Normal Life stage, it only takes days for the patient to see their family physician. Here the physician must make some verdict on the presence of cancer based on patient history, observable signs, and patient observations. While this process often takes a single consultation, in some cases, the physician may request additional tests done outside of the examination before making a verdict extending the length of this stage by days or weeks.

2.2 Information Inputs and Outputs

Inputs	Outputs
• Patient observed symptoms • Physician observed symptoms • Test results • Family history	• Cancer verdict • Medications

2.3 Information Usage

Information	User	Purpose	Frequency	Trans. Issues
Patient observed symptoms	*Physician*	*Aids the physician to form a verdict*	*Always*	*Inaccurate, over/understatement, forget*
Physician observed symptoms	*Physician*	*Aids the physician to form a verdict*	*Always*	*None*
Test results	*Physician*	*Aids the physician to form a verdict*	*Sometimes*	*None*
Family History	*Physician*	*Aid the physician to form a verdict*	*Always*	*Incomplete/Cannot be verified*
Test results	*Patient*	*Gain insight into their illness*	*Depends on degree of patient involvement*	*Typically through physician. Misinterpreted.*

3. Physician Ordered Tests

3.1 Description

This stage involves running the tests requested by the physician during the Examination by Physician stage.

Patients typically need to wait days or weeks to get these tests done due to resource constraints. Once the tests are done, the results are sent back to the physician to aid them in forming their cancer verdict.

3.2 Information Inputs and Outputs

Inputs	Outputs
• Test orders • Test preparation guidelines	• Test results

3.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Test orders	*Lab technician*	*Determine what tests to prepare for and run on the patient*	*Always*	*None*
Test preparation guidelines	*Patient*	*Informs the patient what is necessary to get accurate test readings*	*Always*	*Forget. Ignored.*

4. Surgery for Potentially Cancerous Tumor

4.1 Description

At this point, the physician has identified a potential for cancer in the body and recommends surgical removal as a precautionary measure. Therefore the purpose of this stage is to remove the potentially cancerous tissue and verify it is cancerous.

Once this stage is initiated by a physician referral, the procedure may take weeks or months to occur due to resource constraints. Upon completing the procedure, patients who test negative will return back to their normal lives with regular follow up while those who test positive for cancer are referred to see an oncologist.

4.2 Information Inputs and Outputs

Inputs	Outputs
	• Verdict on the presence of cancer

5. Assessment by Oncologist

5.1 Description

In this stage the oncologist will perform a cancer assessment on the patient to determine its severity.

The waiting list to enter this stage from a physician referral is, on average, a few weeks. During this stage the patient will undergo a variety of tests and scans, involving various primary and secondary care providers. Consequently, this stage lasts for a few days or week as the test results are sent to the oncologist where he/she will make an assessment and brief the patient on their findings.

5.2 Information Inputs and Outputs

Inputs	Outputs
• General information about cancer (symptoms, treatment, effects, survival rate, personal experiences) • Patient medical history • Patient family history • Test/scan results*	• Assessment of cancer severity •

5.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
General Cancer Information	*Patient/Family*	*Improve knowledge, thereby decreasing fear, anxiety*	*Sometimes*	*Inaccurate or incomplete*
Patient medical history	*Oncologist*	*Provides background information for assessment*	*Always*	*Incomplete or inaccessible?*
Patient family history	*Oncologist*	*Provides background information for assessment*	*Always*	*None*
Test/Scan results	*Oncologist*	*Used in the assessment of cancer severity*	*Always*	*None*
Test/Scan results	*Patient/Family*	*To increase participation in the treatment process*	*Sometimes*	*Comprehension*

6. Oncologist Ordered Tests

6.1 Description

This stage involves running the tests requested by the oncologist when they are assessing cancer severity.

Because oncologists typically have testing/scanning resources at their disposal through their care team, the wait time for these tests will likely be shorter than physician ordered tests. Once the tests are done, the results are sent back to the oncologist to aid them in their cancer assessment.

6.2 Information Inputs and Outputs

Inputs	Outputs
• Test orders • Test preparation guidelines	• Test results

6.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Test orders	*Medical*	*Determine what tests to prepare*	*Always*	*None*

	staff	*for and run on the patient*		
Test preparation guidelines	*Patient*	*Informs the patient what is necessary to get accurate test readings*	*Always*	*Forget. Ignored.*

7. Third Party Opinion

7.1 Description

The purpose of this stage is for the oncologist to receive third party input when performing the cancer assessment or seeking an appropriate treatment protocol.

Initiated by the oncologist, this stage typically does not take long to complete. In some cases, this input comes in the form of an informal phone call only lasting a few minutes. In other cases, the patient may actually need to see the specialist but will likely avoid long wait times, extending this stage by a few days.

7.2 Information Inputs and Outputs

Inputs	Outputs
• Test results • Patient history • Patient observed symptoms	• Assessment recommendation • Treatment plan recommendation

7.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Test results	*Third party*	*Used to form recommendation*	*Always*	*None*
Patient history	*Third party*	*Used to from recommendation*	*Sometimes?*	*None*
Patient symptoms	*Third party*	*Used for form recommendation*	*Always*	*May change what oncologist was told*

8. Select Treatment Protocol

8.1 Description

This stage is where the oncologist and patient select a treatment protocol. A treatment protocol specifies many aspects of treatment which, for the purposes of this report, will be simplified into treatment plan and treatment conditions. Treatment plan encompasses the types of therapies, necessary tests, when they will occur, dosages and medications. Treatment precautions encompass physiological requirements to undergo therapy, important symptoms to catch and expected side effects of treatment.

Typically, this immediately follows the patient receiving their cancer assessment. The oncologist will recommend one or a few treatment protocols for the patient to select from. This stage may only last for a period during a single visitation when the patient selects a treatment protocol recommended by the oncologist. In other cases, the patient may request a particular research trial, request an unavailable protocol, or require time to select a course of treatment. In such cases this stage often extends beyond a single day.

8.2 Information Inputs and Outputs

Inputs	Outputs
• Cancer assessment • Available treatment protocols • Recommended treatment protocols*	• Treatment Plan • Treatment Precautions

8.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Cancer assessment	*Oncologist*	*Used to determine appropriate treatment protocol*	*Always*	*None*
Cancer assessment	*Patient/Family*	*Helps patient make a more informed selection*	*Depends on involvement*	*Misinterpretation*
Available treatment protocols	*Oncologist*	*Used to find the recommended treatment protocols for the patient*	*Always*	*May not be aware of all protocols, biased selection*
Available treatment protocols	*Patient/Family*	*Used to become knowledgeable and gain more equal footing*	*Depends on involvement*	*Misinterpretation, invalid selection*
Recommended treatment protocol	*Patient/Family*	*These are the primary protocols the patient will choose from*	*Always*	*Incomprehensible due to emotions, prejudiced interpretation*

10. Treatment Scheduling

10.1 Description

This stage is where the treatment schedule the patient will follow is produced.

This immediately follows the selection cancer treatment protocol. The oncologist and the scheduler will meet and arrange the appointments required by the treatment plan. To do this they must find times that are compatible with the treatment plan, care team availability, and hospital resource availability. Patients are then informed of the schedule afterwards. In some cases, patients may decline certain appointment times which typically result in the schedule being pushed back.

10.2 Information Inputs and Outputs

Inputs	Outputs
• Treatment plan • Care team availability • Hospital resource availability	• Treatment schedule

10.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Treatment plan	*Oncologist/ Scheduler*	*Used to determine the necessary appointments for treatment*	*Always*	*None*
Care team availability	*Oncologist/ Scheduler*	*Used to determine feasible time appointment times*	*Always*	*None*
Hospital resource availability	*Oncologist/ Scheduler*	*Used to determine feasible time appointment times*	*Always*	*None*

11. Treatment Preparation

11.1 Description

The purpose of this stage is to make the necessary preparations before the patient begins cancer therapy.

From the end of the previous stage, this stage may take weeks to begin depending on care team and hospital resource availability. This stage may also last for over a week in cases where numerous preparatory activities are necessary. This includes running tests on the patient to verify treatment precautions are met, monitoring physiological systems that will be impacted by therapy, and preparatory activities for therapy such as measuring necessary parameters and administering pre-medication.

11.2 Information Inputs and Outputs

Inputs	Outputs
• Treatment schedule • Treatment precautions • Physiological tests results* • Treatment plan	• Treatment plan parameters • Treatment precaution verification • Physiological tests results

11.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Treatment schedule	*Patient*	*Determine appointment times. Make necessary lifestyle and transportation arrangements.*	*Always*	*Forget due to long wait times*
Treatment precautions	*Patient*	*Help patient attain or maintain eligibility to undergo therapy*	*Always*	*Forget, disregard*
Treatment precautions	*Medical staff*	*Checked with physiological test results to verify treatment precautions are met*	*Always*	*None*
Physiological test results	*Medical staff*	*See above*	*Always*	*None*
Treatment plan	*Medical staff*	*Specifies necessary parameters needy for therapy*	*Always*	*None*

12. Therapy Session

12.1 Description

This stage represents a single cancer therapy session of a series of specified in the treatment plan.

Therapy will begin shortly after pretreatment preparations are made and therapy sessions are spaced from days to weeks apart. The patient may come from their home to attend the therapy session or may be transferred internally when they are an inpatient. Similarly, depending on the patient’s condition, they maybe discharged to go home or become an inpatient follow a therapy session.

12.2 Information Inputs and Outputs

Inputs	Outputs
• Treatment schedule • Treatment plan parameters • Treatment plan	•

12.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Treatment schedule	*Patient*	*Determine appointment times.*	*Depends on stage of treatment, treatment progress, in/out patient status*	*Changes in patient needs cause rescheduling*
Treatment schedule	*Family/ Friends/ Support*	*Transport the patient to appointments and provide assistance during therapy*	*Depends on in/out patient status*	*Changes in patient needs cause rescheduling*
Treatment precautions	*Medical staff*	*Checked with physiological test results to verify treatment precautions are met*	*Always*	*None*
Physiological test results	*Medical staff*	*See above*	*Always*	*None*
Treatment plan parameters	*Specialist*	*Specifies necessary parameters needy for therapy*	*Always*	*None*
Treatment plan	*Specialist*	*Specifies the therapy to be performed*	*Always*	*None*

13. Progress Monitoring

13.1 Description

This purpose of this stage is to monitor the patient's response to cancer therapy and catch complications as early as possible.

Because there maybe multiple monitoring processes at work, this stage extends from immediately after a therapy session right up until the next session. There are multiple monitoring processes because there are a number of ways the patient is being observed. Sometimes the patient, and possibly their family members, will monitor him/herself for symptoms that indicate treatment complications. Additionally, tests are run on the patient and results are often compared to previous results to monitor the effects of therapy.

Because cancer therapies have serious side effects, identifying treatment complications involves distinguishing the side effects due to therapy from the side effects due to complications. While test results are typically checked against values that signify complications, it is up to the patient, or their family, to take initiative to identify and report symptoms that indicate complications.

13.2 Information Inputs and Outputs

Inputs	Outputs
• Treatment precautions • Patient/family observed symptoms* • Treatment schedule • Previous test results • Test results*	• Need for treatment modification • Patient/family observed symptoms • Test and assessment results

13.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Treatment precautions	*Patient/ Family*	*Identifies the important symptoms to look for in this treatment protocol*	*Depends on patient involvement.*	*Forget, disregard*
Patient/family observed symptoms	*Medical staff*	*Identify treatment complications*	*Often*	*Over and under reporting of symptoms*
Treatment schedule	*Patient/ Family*	*Determine appointment times.*	*Depends on stage of treatment, treatment progress, in/out patient status*	*Changes in patient needs cause rescheduling*
Test results	*Medical staff*	*Identify treatment complications*	*Always*	*None*
Previous test results	*Medical staff*	*Compared against current results to monitor impact of treatment*	*Always*	*None*

14. Mid-Treatment Assessment

14.1 Description

The purpose of this stage is to determine the appropriate change to treatment in response to a treatment complication.

This stage will begin within days of the progress monitoring stage after a complication is identified. In some cases the oncologist can quickly diagnose the cause of the complication based on the patient/family observations and test results from the progress monitoring stage. However in cases where the oncologist requires additional tests, the diagnosis will naturally take longer.

Adjustments to the treatment plan can then be made based on the diagnosis and any prescribed adjustment from the treatment plan. The magnitude of these adjustments can vary from altering therapy dosages, adding/removing/rescheduling therapy sessions, seeing additional specialists, or changing the treatment protocol altogether. Due to the harsh side effects of cancer therapy, in some cases the patient may decline further treatment and enter palliative care which focuses on patient comfort instead of patient recovery.

14.2 Information Inputs and Outputs

Inputs	Outputs
• Patient/family observed symptoms • Test and assessment results • Treatment plan • Diagnosis of complication* • Treatment precautions	• Change to treatment schedule • Change to treatment plan • Change to treatment protocol • Change to palliative care

14.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Patient/family observed symptoms	*Oncologist*	*Help diagnose cause of treatment complication*	*Always*	*Patients will forget or add to reported symptoms*

Test and assessment results	*Oncologist*	*Help diagnose cause of treatment complication*	*Always*	*None*
fTreatment plan	*Oncologist*	*Recommends treatment adjustments to certain complications*	*Always (when available)*	*None*
Diagnosis of complication	*Oncologist*	*Used to determine appropriate treatment adjustment to complication*	*Always*	*None*
Treatment plan	*Patient/Family*	*Provides patient information to decide on appropriate change to treatment*	*Depends on involvement*	*Misinterpretation*
Diagnosis of complication	*Patient/Family*	*See above*	*Depends on involvement*	*Misinterpretation*
Treatment precautions	*Patient/Family*	*Identifies likely side effects that will result from further treatment*	*Depends on involvement*	*Misinterpretation*

15. Post-treatment Assessment

15.1 Description

This stage is similar to the mid-treatment assessment in that both aim to determine the appropriate change to the treatment plan. What differentiates the two stages is the context in which these treatment assessments occur.

The post-treatment assessment occurs shortly after the patient completes their prescribed cancer therapies. Medical staff and the oncologist perform a thorough cancer assessment of the patient to determine the effectiveness of the treatment protocol. Based on this assessment, if cancer is still present, treatment maybe adjusted in various ways similar to the mid-treatment assessment or may go into palliative care. If the signs and symptoms of cancer cannot be found, the patient will go into remission status.

15.2 Information Inputs and Outputs

Inputs	Outputs
• Cancer assessment*	• Change to remission status
Refer to 14.2	

15.3 Information Usage

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
Cancer assessment	*Oncologist*	*Determine the effectiveness of treatment*	*Always*	*None*
Cancer assessment	*Patient/Family*	*Determine the effectiveness of treatment*	*Always*	*None*
See 14.3				

16. Remission

16.1 Description

This stage encompasses the time period when the patient is being monitored for signs of relapses. Its purpose is to catch relapses as early as possible so that they can be quickly treated.

This stage is initiated when the patient enters remission status and will last for weeks when there is a high likelihood of a cancer relapse. Though all signs and symptoms of the cancer have disappeared, cancer may still reside in the body. Therefore the patient must closely monitor for cancer symptoms and will undergo regular testing.

16.2 Information Inputs and Outputs

Inputs	Outputs
• List of significant symptoms • Patient/family observed symptoms* • Test results*	• Detection of relapse • Change to patient status

Information	***User***	***Purpose***	***Frequency***	***Trans. Issues***
List of possible cancer symptoms	*Patient*	*Identifies what symptoms the patient should look for*	*Always*	*Forget, unable to recognize*
Patient/family observed symptoms	*Oncologist/ Medical staff*	*Examines symptoms for signs of cancer relapse*	*Always*	*Incomplete, inaccurate*
Test results	*Oncologist/ Medical staff*	*Help indicate cancer relapse*	*Always*	*None*