Modeling Trust in the System Design Process of an Information System

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DECLARATION

I certify that this work has not been accepted in substance for any degree, and is not currently being submitted for any degree other than that of Master of Philosophy being studied at the University of Greenwich. I also declare that this work is the result of my own investigations except where otherwise identified by reference and that I have not plagiarised the work of others.

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DEDICATION

To Yahweh, to my husband Emmanuel Umoh and my daughters, Laura, Emmanuella and Daniella for making this thesis possible.

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ABSTRACT

Trust has long been recognised as crucial in shaping relationships and all kinds of interactions. In human-system-interaction, trust is becoming a central issue and plays an important role in spanning the gap between humans and information systems, such that the absence of trust can introduce inefficiencies, complicate interactions, require protective actions, and increased vigilance such that actions are double-checked during interactions. This research discusses the role trust plays in influencing user perceptions of information system trustworthiness. Its goal is to identify the factors that can enhance user trust perceptions and how this knowledge could be modeled into system design to create systems that are perceived trustworthy.

The inability to understand the factors that can influence user perceptions of information system trustworthiness can constitute a major obstacle to the success of any information system. Unfortunately, some systems are designed and built without an understanding of these factors. Consequently, users may be unable to satisfy their intentions and achieve their objectives efficiently. The growing dissatisfaction with trustworthiness of information systems by users calls for research into the factors that can significantly enhance user perceptions of system trustworthiness.

A review of the literature on trust in information systems shows that when trust is modeled during system design and development processes, it is sometimes modeled with limited attributes that can only satisfy the core objective of an information system, whereas other important attributes that can enhance trustworthiness are not considered. Trust should be modeled with other related attributes that can enhance user perceptions of trustworthiness.

A number of studies have been conducted to identify the factors that can influence user perceptions of information system trustworthiness. These factors are addressed from different perspectives, therefore an approach is needed to capture the various perspectives

on the current state of the art to produce a set of trust-based concepts that can enhance trust during information system design and development. Considering this constraint, this thesis reviews the body of knowledge on trust and its related concepts. It looks at trust from a multidisciplinary perspective from theories, models, frameworks and empirical studies. This enables it to provide a comprehensive review of the different factors that can enhance trustworthiness in information systems that include the design and development processes. It investigates the current information system design and development methodologies and identifies the gaps on how user trust perceptions are promoted in existing approaches. Additionally, it identifies the key trust attributes that can enhance user perceptions of trustworthiness through an information system survey.

User perceptions statistical analysis of the survey results was performed and the result identified the key attributes of trustworthiness that can enhance user perceptions of information system trustworthiness. These are safe and secured, privacy, accuracy, accessibility, predictability and fast response time.

This thesis identifies the limitations and the challenges of the current state of the art with respect to modeling trust in the system design process of information systems. Additionally, it identifies the factors that can enhance user perceptions of information systems trustworthiness. The factors identified, which include the trustworthy attributes, could be used as guidelines for modeling trust in a system design process by enabling all participants in system design to consider trust during information system design and development.

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CHAPTER I

THE BACKGROUND STUDIES

1.1 Introduction

Information systems can be found in every aspect of human life. They have become an integral part of human activity and humans rely on the services offered by the systems that include banking, education, entertainment, commercial activities, healthcare, research, socialising and work. Despite the high level of human dependence on information systems, research has shown that many systems are often unreliable and humans are faced with the choice between using essential systems that they do not perceive trustworthy or forgo the services they provide (Camp, 2003; Buttlner and Goritz, 2007). Trust can be seen as an important factor in fostering the acceptance, continuous use and the level of satisfaction that humans derive from interacting with systems. A system that is secure, available, and reliable tends to be perceived by users as trustworthy (Bevan, 2011). Therefore, more work needs to be done to identify the attributes that should be present during information system design process to produce systems that are perceived as trustworthy by users.

To address the problem of user perception of system trustworthiness during system design, this thesis will investigate the place of trust in human-to-system relationship. It will investigate the key trust attributes for system design through empirical studies and an information system survey. Additionally, it will investigate some major design methodologies from both academia and industry whilst striving to understand how trust is modeled by them. The discussion starts with how these methodologies evolved over the years, their similarities and differences and how they deal with the issue of trust. Gaps are identified with respect to how each methodology deals with the issue of trust. These gaps expose the need for trust to be modeled in the design process of information systems to enhance trustworthiness.

This first chapter of this thesis lays the foundation for the research presented. It sheds light on a number of key elements such as the problem statement that briefly discusses how information systems are often designed without considering some key issues of trustworthiness from the user perspectives. It discusses the significance of this study and suggests some research questions. The aim and objectives of this thesis are highlighted and the scope of this thesis is explained. The chapter ends with a description of the structure of this thesis.

1.2 The Problem Statement

Trust between individuals develops over time when promises are kept and expectations met building confidence that results in trusting attitudes and behaviours. Information systems are built to provide information and carry out desired actions that meet user and stakeholder expectations. Their performances enable users to build trust in them. However, while designers, developers, and system owners strive to build systems that function correctly and that meet expectations, they may sometimes miss the key issue of trust. Consequently, users and stakeholders are often exposed to uncertainty, vulnerability, and risk while interacting with systems. Some users interact cautiously and hesitantly, double-checking their actions for false information. Zhang et al (2005) explain that users might get frustrated when systems do not meet their expectations. Additionally, Dwivedi et al (2012) suggested that the inability of systems to meet user expectations was largely due to low levels of trust that users have in them. An approach is therefore needed that integrates trust and its associated attributes in information system design to enhance user trust perceptions.

Considerable work has been done on the concept of trust from multidisciplinary perspectives. Additionally, enormous work has been done on trust between people, organisations, societies, governments, markets, etc. More recently, the area of research on trust has shifted to information systems because nearly all the sectors of the world (economy, national defence, security, and personal life) depend on them. Work done in this domain include: initial trust (Luo et al, 2010; Kim and Prabhakar, 2000; McKnight et

al, 2002), trust development and familiarity with technology (Turpin and Hersh, 2001; Su, 2003 McKnight et al, 2011), and the influence of trust on technology acceptance and continuous use (Davis, 1989). Notwithstanding the amount of the work done on trust in information systems, there has been a deficit in the literature on trustworthiness in information system design. The system design and development process, because of the systems characteristics built into it, can heavily influence the trustworthiness of a system.

In recent research studies, the understanding and modeling of trust in system design often deals with a single aspect of trust. For instance predictability (Corritore et al, 2003; Dzindolet et al, 2003; Hoffman et al (2010), privacy and security (Belanga et al, 2002; Camp, 2003; Chin and Older, 2010; Culnan and Armstrong, 1999), accuracy (Corritore et al, 2003), ease of use (Davis, 1989). This shows that when trustworthiness is considered during system design and development, it is sometimes seen as a single attribute whereas it is more complex than this. For instance, a system might be created with a lot of emphasis on security. The resulting system might be trustworthy from the point of view of security, but still fail to be trusted because of deficiencies in other areas such as predictability, accuracy, speed, and ease of use. Although all these attributes are important during system design and development, there is the need for understanding and modelling trust and its related attributes collectively into system design to enhance perceptions of trustworthiness. Currently, there is scope for more research that investigates the wide range of attributes that can be used to model trust in information system design.

1.3 The Research Aim and Objectives

The research aims at identifying the factors that can affect information system user perceptions of trustworthiness and how this knowledge can be modeled into system design to create information systems that are perceived as trustworthy.

In order to achieve this aim, the following objectives were identified:

1. To understand the body of knowledge on trust and its related concepts.

2. To identify the attributes of trust from theories, models, frameworks and empirical studies in information systems.
3. To investigate current methodologies and identify some gaps in the current state of the art with respect to promoting the perception of trust in information systems.
4. To identify the key trust attributes from system user perspectives that can enhance user perceptions of information systems trustworthiness through an information system survey and statistical analysis of the results.

1.4 The Significance of the Study

There is agreement between researchers that information system success can largely be determined by the quality of information and services provided (Delone and McLean, 2002; April and Pather, 2008; Bevan, 2011). These quality dimensions have significant effects on information system trustworthiness and subsequently on the satisfaction derived from system use. If the users are not satisfied with the quality of the information and services provided, their expectations may not be fully met (Elofson, 1998; Petter, 2008), and they may therefore not find the system trustworthy. If a system is not trustworthy from the user perspectives, they may either stop using the system after an initial contact or continue its use only because they feel they have little choice but without deriving satisfaction.

This thesis examines directly what makes information systems trustworthy from the user perspectives by focusing on a collection of trust-related attributes. The ability to establish trust is an important part of any information system and it is currently becoming an issue in system design and development. Therefore, it is important to bring to light the importance of assessing and establishing trust as part of the development process. Much work needs to be done in this area to ensure that trustworthy attributes are considered from the user perspectives during system design. This has to start from the requirement stages of information system development after having a good understanding of user requirements.

Studies have shown that there are two main ways to encourage people to trust something. The first is to put external controls in place to minimise risk and vulnerability (Bachmann and Inkpen, 2011). For instance, signing of a contract or agreement. In such cases, sanctions are imposed if there is a breach of trust from either party (Rousseau et al, 1998). The second is to demonstrate that the object of trust is trustworthy (Pavilidis et al, 2011). This research takes the second approach to trust and suggests that trust in a system can be grounded in users evaluating a system's trustworthiness. This is because every user has a choice to make, and that is whether to trust a system or not and whether a system is sufficiently trustworthy or not. Certain system properties, for instance security and accessibility, can highly influence the development of user trust.

When first encountering a system a user makes an evaluation of a system's trustworthiness resulting in their initial level of trust in the system (Mcknight and Chervany, 2002; McKnight, 2005; Mayer and James, 1999). An initial contact with an information system does not guarantee its continued use because users can stop using it after a while if they become dissatisfied. What is important is designing a system with attributes that can enhance user perceptions of its trustworthiness (Camp, 2003; Hussin et al, 2005; Meng et al, 2011; Stracke and Hildebrandt, 2007).

1.5 The Research Questions

In order to achieve the aims and objectives of this research, this thesis seeks to answer the following research questions:

- How can the concept of trust be understood and related to the human-to-system relationship?
- How can attributes that can promote user perceptions of trust in information systems be identified?
- What are the gaps in current Information Systems Design Methodologies (ISDM) that can hinder user trust perceptions?
- What key attributes of information systems can enhance user perceptions of system trustworthiness?

1.6 The Scope of the Study

Trust in information systems constitutes a bigger picture than the focus of this thesis. It covers some areas described in section 1.2. Within this thesis, we focus on one aspect that in many ways differs from other research and that is modeling trust in the system design process of an information system; an area that needs to be intensely researched because of the role that information systems play in mediating everyday activities. In addition, because trustworthy systems can have the benefit of being developed successfully, being implemented and fully utilised by users.

The present study can be described from three views. The first view is defining the concept of trust in general terms from the body of knowledge. This is to give insight into the meanings, dimensions and applicability of trust. Having looked at trust from this view, the second view seeks to apply trust to information systems and its design process. The third seeks an understanding of how information system users perceive trustworthiness. This extends to include a survey of the views of some individuals who frequently interact with systems.

Trust is not restricted to any specific information system in this context but to a technological system that comprises hardware, software, people, and the interrelationship between them. These embody the utility for accessing, collecting, processing, storing and presenting of specific information that has or is expected to have relevance and impact on system users (Popa et al, 2008; Bacon and Fitzgerald, 2001). Examples of information systems include company websites, online transaction systems, online banking systems, school intranets, hospital medical systems, online networking sites (Acquisti et al, 2010; Camp, 2003; Kumar et al, 2014).

System users in this research context are individuals who interact with information systems, and who when successful, may benefit from the interaction. Information systems exist to satisfy the needs of its users such as training, transactions, pleasure, gaming, education (Bevan, 2011; Corbitt et al, 2003; Abrams et al, 2003).

1.7 The Structure of the Thesis

In order to answer the research questions and meet the research objectives, this thesis comprises six chapters. This chapter is the first chapter and it covers the background of the study.

Chapter 2

Chapter 2 has two sections. The first section reviews the literature on the general concept of trust. Due to the broadness and the multifaceted nature of trust, the topics discussed under the concept of trust are restricted to those topics that are relevant to this research. They include the nature of trust, the relevance of trust and the multidisciplinary view of trust. The chapter then focusses on trust in information systems discussing initial trust, continued trust and their antecedents.

The second section discusses the theoretical models of information systems used for this study. They include the Witness-based Trustworthiness Model, the Thriving Systems Theory and the Delone and McLean Information System Success Model. Chapter 2 gives a brief description of these models, their impact on information systems, evidence of their successful applications in human-to-computer relationships and their relevance to this study. Chapter 2 serves as a foundation to other studies undertaken in the course of this thesis.

Chapter 3

The third chapter identifies some attributes of trust from several frameworks, models and empirical studies. These attributes signify the qualities that users find significant when forming a trust relationship with an information system. The research model adopted for this study is discussed with focus on its relationship and effects on this research.

Chapter 4

The fourth chapter reviews existing information systems design methodologies that have been proposed by both industry and academia and describes how they have evolved over the years. It highlights the similarities and differences between these existing methodologies. Additionally, it presents the analysis of gaps concerning how trust is featured in their development process. Lastly, it examines how user perceptions of trustworthiness can have significant impacts on information system usage.

Chapter 5

In chapter 5, the attributes investigated in the previous chapters are used to conduct an information system survey. Results are gathered and statistically analysed to find the key factors that influence the surveyed user perceptions of the trustworthiness of information systems.

Chapter 6

Chapter 6 presents the conclusions and recommendations for this thesis. It identifies the current state of the art in the design of information systems with respect to incorporating the factors that are likely to instill trust. It gives an analysis of gaps that exist in information systems development. It assesses the fulfillment of the research aims and objectives. Afterwards it provides an evaluation of the research contribution and discusses some limitations faced in the course of undertaking this research. Lastly, it introduces some potential directions for future work that can improve trust features in system design.

CHAPTER 2

LITERATURE REVIEW INTO TRUST AND RELATED CONCEPTS

2.1 Introduction

During the past three decades, the amount of literature published on trust has grown noticeably and so has the diversity and range of viewpoints of researchers who work on the subject. The objective of this chapter is to present the body of knowledge on trust and concepts closely related to it.

This chapter is in three parts. The first is on the general view of the concept of trust where trust is considered as an essential part of social and individual human life. In this section, trust is delineated from trustworthiness and the role of trust in facilitating relationships is discussed. Trust is seen to be multifaceted, therefore there is no single definition of trust that cuts across all the disciplines (Beldad et al, 2010; Bevan, 2011; Camp, 2003). To capture the meanings, and definitions of trust, this chapter discusses the nature of trust by focusing on the elements that constitute trust. This is followed by a review of trust from a multidisciplinary perspective. Attention is given to the social sciences because they give a view of the conceptualisation of trust as it relates to the objectives of this thesis.

The second section of this chapter discusses trust as it relates to information systems. It starts with the definition of the human-to-system trust relationship and then continues with how human-to-system trust can be seen as a form of interpersonal relationship. There are some similarities and differences between the human-to-human relationship and human-to-system relationship when it comes to the issues of trustworthiness and this is discussed in this chapter. The comparison points out the reason people rely on systems to fulfill expectations knowing that they are not humans but human made artefacts. The

last discussion in this section is on information system usage and the factors that may affect system users while interacting with information systems.

Information system usage is pre-requisite for any human-to-system trust relationship (Hoehle et al, 2012). Initial trust in a system can be influenced by information system usage. Some individuals develop trust in a system during an initial contact (McKnight, 2005; Kim and Prabhakar, 2000; Koufaris and Hampton-Sosa, 2007), and some through longer term use (Adapa and Cooksey, 2013; Bhattacherjee, 2001). Each of these ways of developing trust can be influenced by what an individual has heard about the system even before using it (Sieber and Valor, 2008). The topic of initial trust versus trust developed through ongoing use has gained interest among researchers, and will be considered in this chapter.

The last section of this chapter discusses some models and theories used in this thesis. They intend to provide an insight and understanding into what triggers human-to-system relationships, the management of these relationships and how they can be optimised to promote trust. These theories and models serve as a framework and guidance in achieving the research aim of identifying some key factors that can enhance system user perceptions of information systems' trustworthiness. They are the Witness-based Trustworthy Model, the Thriving System Theory and the Delone and MacLean Information System Success Model (Liu et al, 2012; Waguespack, 2010; Delone and McLean, 2002). These three sections tackle the research question of how the concept of trust can be understood and how the concepts can be integrated into human-to-system relationship. An overview of the discussions made throughout this chapter is given as a summary at the end of this chapter.

2.2 Trust and Related Concepts

2.2.1 Trust and Trustworthiness

This section begins by explaining some basic terms and concepts of trust. The first term is "the trustor", the principal actor that makes the decision to trust. The second is "the trustee", the object of trust or the person whom trust is invested upon (Lyon et al, 2012). For instance, in a trusting relationship, that involves X, Y and **α**. 'X' can be referred to as the trustor who feels the trust. The trustor could be an entity, a person, or group of persons. 'Y' is the "trustee" or an entity that is trusted who could be a person, a system or an organisation and 'α' is the outcome from the trusting relationship. Therefore, a trust relationship may be referred to as **X** Trust **Y**= **α.** In this example, X relies on **Y** for an outcome **α** because **Y**'s action is useful to X (Castelfranchi and Giardini, 2006)**.**

In order to understand the concept of trust, there is need to differentiate trustworthiness from trust, as they are not the same. There is a significant difference in terms of their cause and effect relationships. To trust is to rely willingly on a trustee based on an expectation from the trustee. Trustworthiness is the characteristics of a trustee who is potentially the object of trust (Abrams et al, 2003; Baker, 1987; Barney and Hansen, 1994; Colquitt et al, 2007).

2.2.2 The Role of Trust in a Modern Society

Trust has a pivotal role in modern societies and plays an important role in many areas of human life. In workplaces, the effect of trust among co-workers, supervisors and management is shown by the level of commitment and the willingness to be vulnerable to each other. Empirical studies show that trust increases team interaction, knowledge sharing, successful collaboration, performance efficiency, and the motivation needed by each team member to work towards a shared objective (Colquitt et al, 2007; Moye and Henkin, 2006).

In business contexts, the ability to gain the trust of customers and stakeholders is very important. Therefore, businesses will invest considerable resources to gain the trust of their associates. Studies show that companies that are characterised by a high degree of customer trust are often more successful than the ones that are not (Tan and Lim, 2009). A survey by Horsager (2011) showed that companies that sustain high levels of trust from their clients, suppliers and stakeholders, outperform those who do not. Another study showed that trust enables businesses to build partnerships more quickly and promote an atmosphere of openness because information is exchanged freely between business partners and inter-organisational relationships strengthened (Svensson, 2005).

Trust is crucial in commercial and economic activities, especially with the advancement in technology following the introduction of the internet. Subsequently, information system capabilities have gradually developed from central internally controlled rigid systems to less structured globally distributed and largely internet linked systems (Lanc and Mackinnon, 2003). Markets are interrelated and compete with each other through both online and offline economic exchanges in an attempt to give the highest quality of goods and services to their stakeholders in order to gain their loyalty. Trust can be influenced by many factors such as efficiency of transactions, efficient customer service management, efficient cooperative relationships (Gambetta, 2000; Beldad et al, 2010), and the establishment of social presence that demonstrates how a firm represents itself in an online community (Gefen, 2000). In 2009, a survey was conducted by one of the world's leading independent public relation firms with about 4,475 individuals between the ages of 24-64 in five continents. The results showed that when people trust a company, 91% of the trusting individuals would choose to buy from that company, 76% would recommend it to their friends and families, 55% would choose to pay a premium to use it, while 42% would share their experiences online, and about 20% would buy shares from it (Edelman, 2009). This provides evidence that trust has the ability to increase both commercial and economic activities between firms, their customers and stakeholders.

In political terms, trust is important and its consequences may have either direct or indirect effects on the support of any politician and his or her regime. Mishler and Rose

(2005) hypothesised that trust has a direct effect on the survival of a political regime and its effective functioning. They argued that trust builds a fiduciary relationship between the government and the people governed, allowing the government to make decisions that provide long-term benefits to the people. In addition, people need to be free in making choices that are beneficial without fearing the consequences (Solomon and Flores, 2001). Therefore, trust in a politician or a government relies on their sense of responsibility and integrity.

2.2.3 The Concept of Trust

Trust has been conceptualised, defined, operationalised and modeled in various ways for decades (Rotter, 1967; Rousseau et al, 1998; Mayer and James, 1999). Consequently, substantial progress has been made in understanding human-to-human trust relationships (Mayer et al, 1995), and human-to-system trust relationships (Camp, 2003). In spite of the decades of research on trust, the meanings of trust are so diverse that it is impossible to articulate a single precise definition that cuts across the various bases and meanings of trust (Gambetta, 2000; Corritore et al, 2003; Josang and Presti, 2004; Beldad et al, 2010).

It is crucial to identify the bases for trust as part of the steps needed in the discussion of the concept of trust. The bases for trust can be considered as the foundation for any trusting relationship. This section briefly examines the various bases for trust and some definitions associated with trust.

- **Knowledge-based trust**: comes from the accumulation of relevant knowledge about a trustee. It is the ability to predict the trustee's behaviour based on past performances with other parties and with the trustor (Dooney et al, 1998; Gefen et al, 2004).
- **Calculative-based trust:** comes because of a trustor's rational calculation of costs and benefits associated with a trusting relationship. It involves having a diligent and thorough evaluation of the behaviour of a trustee and the likelihood that he or she will fulfil his or her obligations (Lee and See, 2004). Additionally,

it involves a trustor's mental assessment of the benefits of engaging in a trusting relationship versus the risk involved in trusting (Das and Teng, 2004).

- **Characteristics-based trust:** It is based on the attributes that are identified in a trustee For instance, age, or a quality that serves to identify them (Gefen, 2004). Rousseau et al (1998) defines it as a trustor's willingness to depend on a trustee because of the trustee's characteristics.
- **Affective-based trust:** is trust based on emotion, and can develop when emotional attachment between two parties develops (Lewis and Weigart, 1985; Jones, 1996). Mayer et al (1995) explains that affective trust is a trustor's attitude of optimism that the goodwill and competence of a trustee will extend to cover the area of interactions with expectations that the trustee will be directly and favourably moved by the thought that the trustor is counting on the trustee.
- **Cognitive-based trust:** is trust that is based on good reasons that constitutes evidence of a trustee's trustworthiness (Lewis and Weigart, 1985). It is defined as a trustor's willingness to rely on a trustee's competence and reliability that may arise from accumulated knowledge that allows the trustor to predict the behaviour of the trustee (Manapat et al, 2012; Dashti et al, 2009; Gefen et al, 2003; Gambetta, 1988). Although cognitive-based trust is knowledge driven, the need to trust means that the knowledge about a trustee is always incomplete. Nevertheless, the trustor has enough information and understanding to be able to predict the trustee's behaviour (Mayer et al, 1995).

2.2.4 The Nature of Trust

This section describes the nature of trust by focusing on some elements of trust. Whilst discussing the nature of trust, some definitions of trust are examined. Trust can be described as a feeling (Giffin, 1967; Josang and Presti, 2004), expectation (Daechun and Kim, 2008), belief (McKnight and Chervany, 2002), intention, attitude (Deutsch, 1958), risk taking (Kim and Prabhakar, 2000), reliance (Zaheer and Harris, 2006), and faith (Johnson and Grayson, 2005).

There are four elements of trust that are frequently discussed in the literature, which relate to the objectives of this thesis. They are derived from the profusion of definitions of trust given by researchers in various disciplines. The first element centres on trust as an expectation with respect to the behaviour of the trustee (Beldad et al, 2010; Luhman, 1979; Rotter, 1967; Daechun and Kim, 2008). The second is based on the risk factor in a trusting relationship (Das and Teng, 2004; Currall and Judge, 1995; Mayer and James, 1999; Gambetta, 2000; Zaheer and Harris, 2006). The third is the willingness of the trustor to rely on a trustee (Pettit, 2004; Currall and Judge, 1995; Zaheer and Harris, 2006; Kim and Prabhakar, 2000). The last is the willingness of the trustor to be vulnerable to the trustee because of an expectation (Mayer and James, 1999).

There can be more elements than these four but this thesis focuses on these four elements because they interrelate in most trusting relationships in either human-to-human relationships or human-to-system trust relationships. They are common in most trusting literature and are elements needed to build trust across the various bases of trust. Additionally, they can assist in describing the concept of trust in relation to this research objective. Figure 1.1 shows the four elements of trust and their trust relationship.

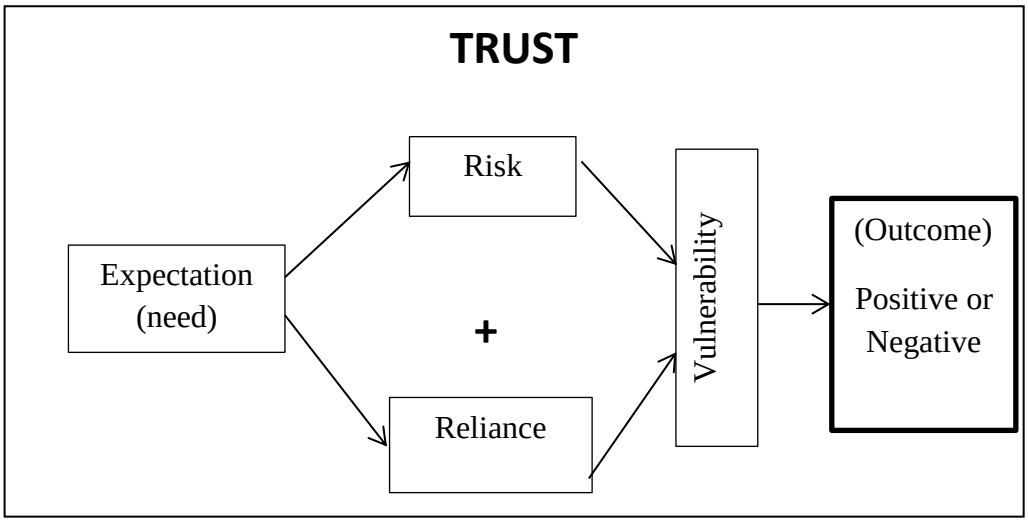


Figure 1.1 The relationship among the elements of trust in a trusting relationship from the perspective of the trustor

Figure 1.1 shows the relationship between the four elements of trust that have been discussed. It starts with a trustor's need for something and an expectation of an outcome. The trustor exposes him or herself to risk by relying on the trustee. During this process, he or she becomes vulnerable to the actions of the trustee. The outcome may be either positive or negative, but in most trusting relationships, the trustor expects a positive outcome until there is a reason not to trust. Reasons to lose trust could include suspicion, swindles, delay and dissatisfaction. These four elements, their effects and interrelationships are discussed briefly in the next sub-section.

1. Trust as an Expectation

Expectation is one of the elements of trust. It focuses on the future aspect of a relationship. It is a perception of what a trustor anticipates is likely to happen (Lancton and Wison, 2007). Rousseau et al (2008) explains that trust comprises the intention to accept vulnerability based on the trustor's expectations of reciprocity. The expectation of reciprocity refers to the trustor's belief in a potential positive outcome. While Failey and Flechais (2014) explain that trust is an internal state of a trustor concerning the expected behaviour of a trustee in a relationship, Wang and Liao (2008) explain that expectations originate from personal needs, past experiences and communications either from the trustee, or with another party.

Some researchers have agreed that there are three strong beliefs that a trustor needs to possess in order to have an expectation of a positive outcome (Mayer et al, 1995; McKnight et al, 2002). The first is the belief placed on the trustee's ability. Ability refers to the skills or competence of the trustee that enables him or her to have influence in a certain area. The second is the belief placed on a trustee's benevolence. This refers to the expectations that the trustee will have a positive desire to do well in response to the trustor's trust by caring and acting in the trustor's interest, and will not act opportunistically. The third is the belief placed on the trustor's integrity. This deals with the expectation that the trustee will act in accordance with socially accepted level of honesty and sincerity and will fulfil his or her promise. A trustor's expectations may be based on any of the three beliefs or a combination of any two or all the three beliefs.

2. Trust as a Risk Taking Exercise

Risk taking is engaging in behaviour that has the potential to be harmful or dangerous (Kim and Prabhakar, 2000). There is an agreement among researchers about the presence of risk in every trust relationship. Trust makes risk more conspicuous because the need for trust increases as the risk associated with a trust relationship increases (Lee and See, 2004; Corritore et al, 2003; Currall and Judge, 1995; Das and Teng, 2004).

Risk is inherent in the development of trust because trust is not necessary if actions are pursued with absolute certainty. Josang and Presti (2004), while analysing the relationship between risk and trust, used a case study with two possible outcomes. The first outcome was a gain factor that was associated with a successful transaction, and the second factor was associated with a loss outcome resulting from a failed transaction. With this illustration, they opined that for any trusting relationship, there are two sides, the gain side that can be favourable and arbitrarily large, and the loss side that can be unfavourable and unpredictable.

3. Trust as Reliance

Reliance is the act of depending on a trustee (Jiang et al, 2009; Rousseau, Sitkin and Camerer, 1998; Rousseau, 1998; Zaheer and Harris, 2006). This implies that for a trustee to be rated as trustworthy in relationships, he or she should be capable of manifesting the characteristics that will increase the trustor's reason for reliance, for instance, honesty, benevolence, predictability.

Wang and Liao (2008) put forward two states for reliance to take place. The first is that the trustee must be aware of the fact that the trustor is relying on him or her to fulfil certain expectations. The second is that while the trustor has made the trustee aware of his or her reliance, the trustor will be expecting that the reliance will give the trustee extra reasons to act as expected.

4. Trust as Exposure to Vulnerability

Vulnerability is another element present in trusting relationships. It stems from the risk involved in a person's reliance on a trustee, and is a form of weakness possessed by the trustor that potentially allows him or her to be exploited. There seem to be an agreement between researchers about the importance of vulnerability in any trust relationship (Lewicki and Bunker, 1995). For instance, Coleman, (1990) defines trust as the action that increases ones vulnerability. Rousseau et al (1998) posited that trust is a sociological state that comprises the trustor's intentions to accept vulnerability based on the positive expectations of the trustee. In addition, Mayer et al (1995) defines trust as the trustor's willingness to be vulnerable to an exchange partner.

In most relationships, the intentions of the trustee is not to deliberately hurt the trustor, knowing that the trustor maybe defenceless, at risk or open to attack, instead, the trustee is hopeful that the vulnerability of the trustor will not be taken for granted. Consequently, Bidner and Jackson (2013) argue that almost every economic transaction entails scope for opportunism. This vulnerability makes trust necessary.

In a trusting relationship, a trustor's risk and their reliance on a trustee, makes him or her vulnerable to the actions of the trustee. For instance, a trustor who is exposed to vulnerability while relying on a surgeon for a major surgery is taking a risk of undergoing the operation. The risk is because there is the possibility that the surgery may not be successful. In most instances, risk and vulnerability are positively correlated meaning that the higher the risk, the greater the vulnerability and vice versa. The relationship between risk and vulnerability is that risk is exposure to threat, loss, danger, hazard etc., while vulnerability is the state of being exposed or susceptible to threat, loss and danger.

2.2.5 A Multidisciplinary View of Trust

There are many perspectives from which trust can be viewed. Every discipline views trust from their own perspective and that makes it difficult to identify a unified view of the concept of trust (Lyon et al, 2012; Mcknight and Chervany, 2002; Gambetta, 1988;

Luhman, 1979). The aim of this section is to discuss how some of these disciplines view trust in order to give a wider conceptualisation of trust.

Some disciplines view trust as a social factor among trusted parties in a social system (Mcknight and Chervany, 2002; Rotter, 1967), some as reliance on a trustee that is compelled by social constraint or the force of norm. Trust is viewed as an economic lubricant that reduces the cost of transactions between parties and an element of relationship in business environment. In some disciplines, trust is viewed based on the characteristics of the trustee while to some, trust is based on the fulfilment of obligations (Camp, 2003; Luhman, 2005). Additionally, some perspective of trust is on reasoning and knowledge where individuals search for sincerity and commitment (Cooper et al, 2008; Fu, 2004; Castelfranchi and Giardini, 2006). Trust permits mutuality of influence and self-control and seeks to eliminate abuse of others' vulnerability (Cofta, 2007).

The study of trust cuts across various disciplines as indicated above. Some of the perspectives from these disciplines connect with the objectives of this thesis while some do not fully connect. The social perspectives on trust best connect with the objectives of this research. It shows that trust is one of the most important elements of social reality that captures any form of relationship between social groups, between people, organisations and between systems (Gambetta, 2000; Horsager, 2011; Lewis and Weigert, 1985). Human trust in information systems captures the social aspects of trust relationships. In addition, empirical research in information systems shows that most of the other disciplines derive their definitions from the social perspectives of trust and most especially, from the fields of philosophy, sociology and economics (McAllister et al, 2006; Walczuch and Seelen , 2001; Luhman, 1979 and Corbitt et al, 2003). Therefore, this section focuses on these three disciplines.

1. The Psychological View of Trust

Trust is not visible, and so psychological research seeks to investigate its internal dynamics. These comprise emotions, beliefs, attitudes, intentions and expectations (Earp, 2010). The Mcknight and Chervany's Trust Model agrees with the psychological view of

trust (McKnight et al, 2002). It explores the tendency of a trustor to trust others that is known as the "disposition to trust" (McKnight andChervany, 2002). Erikson discussed this view decades ago as part of his Personality Theory (Erikson, 1950). He analysed the developmental psychology in children and adults. For children, he found that trust could be seen during the first stage of psychological development that occurs during the first two years of their lives when a child gets the first feeling of security from either their carer or parents. Thus, a failure to fulfil this basic need by a carer or parent leads to insecurity and mistrust (Erikson, 1950). For adults, some individuals are more prone to trusting than others. This shows a variation in the propensity to trust. The Erikson's personality theory, though old, is still in use by modern researchers.

Apart from the initial development of trust in infants, some researchers agree that trust can be viewed from an individual level and is best understood by looking at the psychology of a person involved in a trusting relationship (Earp, 2010; Fadiman and Frager, 2002). Consequently, while some people are predisposed to trust, others find it very difficult to trust despite being surrounded by circumstances and situations that encourage trust.

2. The Sociological View of Trust

Trust from the sociological perspective seems quite different from the psychological perspective because, as viewed by the sociologists, its manifestations are more visible and easy to recognise. Examples of this perspective on trust istrust in local police, who are recognised by their police uniforms (McKnight and Chervany, 2002; Acquisti et al, 2010; Jones, 1996).

Trust in the sociological context is concerned with the social systems where trust is a factor embedded within the social properties of relationships among people or organisations (Fu, 2004). This shows a form of institution-based trust because it is not limited to an individual behavioural intention as in the case of the psychological view (Castelfranchi and Giardini, 2006).

Trust in social relations is a product of an individual's dependence on others where an individual's need may require some services provided by another. The major difference

between the sociological perspective of trust and other views of trust is the emphasis placed on societal social factors (Castelfranchi and Giardini, 2006). The sociological view of trust considers that the actions and behaviour of the trustor are not determined by factors within the person, as in the psychological view, but by environmental factors or situations (Earp, 2010). Whereas, the view of trust from the psychological perspective places emphasis on an individual's psychological differences.

3. The Economic View of Trust

The economic view of trust deals with the trusting intention of individuals (Mcknight and Chervany, 2002; Manapat et al, 2012). It is cognitively based and a central component for social and economic interactions among people (Hassan, 2010). It signifies a purely calculative trust behaviour in which a trustor forms subjective probabilities regarding the future action of a trustee (Hall and McQuay, 2010). In addition, it agrees with rational choice theory that is a framework for the understanding and modeling of social economic behaviour (Colander and Barkley, 2004).

In the development of economic trust, there seem to be an agreement between researchers and practitioners' views in placing a growing emphasis on the importance of social relations underpinning many economic transactions (Forlong, 1996; Bruni, 2010; Corbitt, Thanasankit, and Yi, 2003; Palmer, 2009; Scott, 2000; Rousseau et al, 1998). Most economic institutions have to turn their approach into a social one to gain the trust of their customers and stakeholders.

Whilst there are different perspectives on trust across these disciplines, there are also some commonalities, which can be summarised as follows:

- There is always a trustor and a trustee
- There is always a risk associated with trust relationship
- The trustor must always be willing to become vulnerable.
- There is always an expectation by the trustor about the trustee's future behaviour

- The trustee has a direct bearing on the welfare of the trustor by acting in the interest of the trustor

2.3 Trust in Information Systems

2.3.1 Definition of Trust in Relation to Information Systems

Research has shown that people respond to information systems as they would towards other people and this can be triggered when those systems exhibit certain characteristics of trustworthiness as found in humans such as predictability, ability, accuracy (Lee and Nass, 2010; Camp, 2003; McKnight, 2005). In a human-to-human trust relationship, both the trustee and the trustor are human, but when considering trust between a human and a system, the trustee is not a person but a computer based information system.

Human-to-system trust relationship involves a trustor's expectations about whether a system will support the interactions expected by the trustor. A theory of trust that applies to human-to-system trust propounded by Mur (1987) describes trust as a subjective expectation of future performance of a system that provides the basis for a human-to-system relationship. This theory of trust stresses technical competence, knowledge and the ability to produce consistent and desirable performance. Shnaider (1998), in agreement with this view, pointed out that trust in an information system is based on an evaluation of the system's characteristics.

A working definition for human-to-system trust relationship is needed for this study. Different authors, as evidenced whilst reviewing the literature, have identified many definitions. Amongst the several definitions of trust, this research draws inspiration from two definitions that are useful for this research. The first definition comes from Mayer et al (1995) who defines trust as a willingness of a trusting party to be vulnerable to the trusted party based on the expectations that the trusted party will perform a particular action that is important to the trusting party, without the trusting party monitoring or controlling the trusted party. The second definition is the definition by Rousseau et al

(1998) that states that trust is a psychological state that comprises the intention of the trustor to accept vulnerability based on the positive expectation of the behaviour of the trustee.

The definition of trust from (Mayer et al, 1995) and the definition from (Rousseau et al, 1998) identify the trustor's willingness to be vulnerable as a condition for trust to exist. They also identify the trustor's expectation as a factor for willingly accepting vulnerability. These two definitions are adopted and modified as the working definition of this research. Therefore, the working definition for this research is as follows: *Trust between a user and an information system is the willingness of a user to be vulnerable to the actions of an information system, based on the expectation that the system will behave satisfactorily without the user monitoring or controlling the system*. This definition of trust is applicable to an information system that is expected to satisfy the trustor based on the characteristics it possesses in response to expectations. It is centred on rational and interpersonal trust. It is rational because it is based on good reasons that constitute evidence of a trustee's trustworthy characteristics, and interpersonal because it involves a relationship between two actors, an information system user who is the trustor and a computer based information system.

2.3.2 Interpersonal Trust in Relation to Information Systems

Drawing upon the work from the multidisciplinary view of trust, research has found that trust is not only useful or necessary in relationships, it is also central to the understanding of an individual's behaviour in diverse domains, including the information systems domain (Semercoiz et al, 2011). Moreover, within the information system domain, trust is usually defined in terms of human-to-system relationships (McKnight et al, 2011) that is, a form of interpersonal trust relationship (Hassan, 2010; Dirks, 1999; McAllister, 1995).

Interpersonal trust in general terms is described as the extent that a person is willing to accept risk based on expectations regarding an object of trust (Gambetta, 1989; Semercoiz et al, 2011). When a person forms a trusting relationship with an information system, it is because the person perceives that the system has a set of characteristics that

he or she can rely upon. Information system researchers have debated whether notions of trust that describe human-to-human trust can similarly be applied to the human-to-system relationship (Riegelsberger et al, 2005; Camp, 2003; McKnight, 2005). Certain groups of researchers agree with notion while others do not. Those who agree suggest that system users have the tendency to judge the trustworthiness of an information system in the same manner that they assess the trustworthiness of other people (Lee and Nass, 2010; Constantine, 2006). A study led by "Computers Are Social Actors" (CASA) showed that people respond to information systems in the same manner they would towards other people (Lee and Nass, 2010).

2.3.3 Similarities and Differences between Human-to-Human Trust and Human-to-System Trust

There are some similarities between human-to-human trust relationships and between human-to-system trust relationships. Lee and Nass (2010) suggested that people tend to look for trust elements found in humans in information systems. Earlier in this chapter, the nature of trust was analysed to include expectations, reliability, risk and vulnerability. These can be found in both human-to-human trust relationships as well as human-to-system trust relationships. Additionally, there are some basic similarities between the two forms of trust relationships (Mur, 1987; Rempel et al, 1985; Camp, 2003). They are:

1. The foundation of trust. This represents the assumption that makes trust possible. It is the goal of engaging in a trusting relationship and the starting point of a trustor's engagement in a trust relationship based on an expectation of a beneficial outcome.
2. The performance. This is the outcome of the trust relationship. Performance can be satisfactory if the predicted outcome is positive and consistent. Trustors have the tendency to judge the trustworthiness of a system in the same way they assess the trustworthiness of human trustees.
3. An understanding of the trustor's underlying qualities that govern his or her behaviour. In humans, this may be personality traits such as disposition to trust, or an attitude.

4. The underlying motives for trust. Every trustor expects a positive outcome from their trustee, be it in a human-to-human relationship or in a human-to-system relationship. There is always a motive to trust. Such motive could be for pleasure, to fulfil responsibility as in a work place or home, or for exchange as in purchases. Users are attracted to systems that match their motives.

Trust in an information system involves whether the system will respond positively as expected by its users or not. The differences between human-to-human trust and system-to-human trust are as follows: (Lee and Nass, 2010; Camp, 2003; McKnight and Chervany, 2002).

1. For human-to-human trusting relationships, responding to a trustor's expectations is a choice. A human trustee can choose whether to respond or not to a request but for a system, responding is not a choice.
2. For a system, the response is pre-programmed and maybe structural. For instance it might be control algorithms that control systems behaviour. In human-to-human trust relationship, response may not be structural or pre-programmed.
3. Systems are human-created artefacts with a limited range of behaviour, that is they lack feelings, morals, emotions etc. For instance, technology cannot reciprocate emotions. It cannot take on more responsibilities above what it is designed to do because this might lead to system failure. Systems do not have the subconscious and hormonal mechanisms that can affect bond formation and social risk aversion. Risk aversion is the reluctance of a person to accept risk even when exposed to uncertainty such as the use of unsecured websites.

An information system is an inanimate artefact created by humans. Therefore, by trusting the system the users are actually placing trust in the humans behind the system. A similar situation exists for any technological artefact such as a bridge or airplane. The humans include the designers, developers, maintainers and those who commissioned the system. They work behind the scene and are invisible to the users or to the public eyes (Dashti et al, 2009). Therefore, these humans behind the scene strive to make sure that their systems possess what users need in order to gain their trust.

2.3.4 Information System Reciprocity

Researchers have suggested that trust is a two-way relationship and is reciprocal in nature (Acquisti et al, 2010; Camp, 2003; Gambetta, 2000; Hardin, 2002; Grabner-Krauter and Kaluscha, 2008). Two-way relationship is a form of interpersonal relationship. Whether a trustor is interacting with a trustee, who could be a human or an information system, the trustor believes that the trustee will respond in an expected manner. Arguably, among all the technological systems that depend on trust for existence, the virtual community e.g. e-business, e-market, social networking sites, stand out in terms of magnitude of the challenge in maintaining and reciprocating trust (Jarvenpaa et al, 1999). Reciprocity refers to a practice of exchange with another party for mutual benefits (Bruni, 2010). An example is the use of feedback and reviews in a market trust mechanism and in social networks.

Information systems reciprocate trust in several ways. A trustor can respond to an information system by engaging in an intimate self-disclosure in the context of interpersonal relationship. This often occurs when an information system exhibits some personality related characteristics. An example of this is when an information system responds to text or speeches from a user in an accurate and predictive manner (Lee and Nass, 2010).

2.3.5 The Mediating Role of an Information System

An information system can perform a mediating role between users. When an information system responds to a user by passing information to another user, the system is said to have acted as a bridge between two people (Lee and Nass, 2010). As information systems penetrate every aspect of the human lives, many daily activities are performed through communication with those systems and trust in those systems becomes a critical factor.

There are some ways whereby information systems can perform mediating roles between users. In some commercial websites, they provide the summaries of a user's history and represent them by a rating score that is calculated based on an individual's cumulative

average ratings (Bolton et al, 2012). This is a form of assistance to potential customers in their decision-making. Some organisations make use of escrow services such as Paypal for secure payments and some provide history-reporting features to evaluate their own risk profile for any engagement or transaction with any seller (Chen et al, 2010; Bolton et al, 2012). When a crisis exists, an information system such as the Multi-Agency Crisis Management System can generate rapid negotiation and decision from senior managers, executives, senior local authority or local government executives for the proper functioning of the civil society (Mackinnon et al, 2013). An information system such as Wikipedia is a user editable website that supports document preparation from the public or any authorised user (Parker and Chao, 2007). In social networking sites, users are enabled to access each other's profiles and form relationships for online discussion forums, chat rooms and other social online activities (Abbasi et al, 2011; Cary, 2015). In such instances, information systems are able to satisfy the mediating role of trust between each system user.

2.4 The Effect of Trust on Information System Usage

There are potential benefits associated with the use of information systems. The benefits include instant information exchange. Users can exchange information and take part in many other activities from the comfort of their homes, offices, or any other location. Such activities may range from shopping, bill payment, charting, group discussions and information search (Barney and Hansen, 1994). Information system usage can attract some economic and financial benefits. Members engage in business transactions and commercial activities within the virtual communities they belong. An example is the eBay where members can exchange their goods and benefit from each other right from the comfort of their homes (Chopra and Wallace, 2003).

Information system usage can serve as a platform for administration and for the control of strategic management of an organisation (Al-Aboud, 2011; Morgan, 2002). Organisations can create and deploy technology to suit their objectives (Basahel and Irani, 2010).

Additionally, information systems can serve accounting purposes, support learning and improve knowledge, support collaboration and decision-making processes (Basahel and Irani, 2010; Al-Aboud, 2011). In all these interactions and many more, trust is viable because trust is the expectation by the trustor that the information system, that is the trustee, will perform satisfactorily without the need to monitor or control the system (Mayer, Davis, and Schoorman, 1995; Rousseau, Sitk and Camerer, 1998). This section discusses the effect of trust on information system usage. It argues that both initial trust and trust that develops over time from continuous use have significant impact on information system usage.

A number of studies have aimed at the understanding of how trust affects the initial adoption and subsequent use of an information system (Hoffman et al, 2010; Bhattacherjee, 2001; Hardin, 2002). Theoretical and conceptual research has shown that trust is one of the key determinants of human-to-system relationships (Jarvenpaa et al, 1999; Mayer and James, 1999; McAllister et al, 2006; Ridings et al, 2002) and that it subsequently influences users' acceptance and use of information systems (Hoffman et al, 2010). In line with this, attention is given to two dimensions of trust associated with information system usage. They are: 1) initial trust and 2) trust that develops over time through ongoing use of an information system.

2.4.1 Initial Trust

Initial trust can develop when a user visits and explores a system for the first time. It is defined as trust developed by an unfamiliar trustee (Luo et al, 2010). Initial trust is a product of relationship that develops when a trustor and a trustee, who do not have credible information about each other and have not developed bond with each other, first encounter each other (McKnight et al, 2002; Fuller et al, 2007). The concept of initial trust suggests that human-to-system trust is the driving force for early adoption of an information system (Koufaris and Hampton-Sosa, 2007; Luo et al, 2010; Kim and Prabhakar, 2000). In agreement with this, McKnight et al (2002) developed a theoretical model of consumer trust in e-commerce. Within this model, they proposed three factors that are responsible for the formation of initial trust. They are: reputation, perceived

website quality and structural assurance programs. Structural assurance is based upon mechanisms such as written guarantees, financial regulations, socio-economic safety nets, financial subsidies and so on. These three factors are not limited to e-commerce systems, but include other forms of information systems such as customer service systems, marketing systems, payroll systems, academic sites, social network sites, financial institutions such as banks (Abrams, Cross et al, 2003; Brooks, 2001).

Another model that investigates the influence of initial trust is the Technological Acceptance Model (Davis, 1989). This model suggests that perceived usefulness, perceived ease of use and external variables, predict system users' acceptance of an information system. In addition to these factors, Kim and Tadisa (2006) suggest that propensity to trust, company profile, the supporting organisation and website qualities are factors that can affect initial trust. The key factors from these three models, in addition to other factors that have impact on initial trust, are discussed in the next sub-section as determinants of initial trust in human-to-system relationships.

2.4.1.1 The Determinants of Initial Trust in Human-to-System Relationship

1. **Propensity to Trust (PTT)**

Researchers have found that propensity to trust may have a great impact on initial trust (Kim and Tadisina, 2006; Fadiman and Frager, 2002; McKnight et al, 2002). Propensity is a natural tendency in a person to behave in a particular way. Propensity to trust is a person's dispositional tendency to trust others and can be considered as a personality trait (Colquitt et al, 2007). Following this, it was argued that individuals vary on the level of trust they are willing to extend to their trustees, and this could be influenced by their propensity to trust (Mayer and James, 1999; McKnight and Chervany, 2002). Similarly, some individuals display greater disposition to trust an information system despite having limited information about it, while others find it extremely difficult to do so unless adequate information is available (Beldad et al, 2010).

A good previous experience with other systems could increase a person's propensity to trust another system during an initial contact (Kim and Tadisina, 2006). If someone

placed a lot of trust in a system and was disappointed in it, his or her propensity to trust may be affected negatively and therefore, the propensity to trust another system may be low. The reverse is also true. Ridings et al (2002) hypothesised that a trustor's disposition to trust will be positively related to a trustee's ability, benevolent and integrity. These three factors may not determine a trustor's propensity to trust, but can influence it positively during an initial contact.

2. Physical Design of an Information System

Physical design is described as attention-grabbing aesthetic content or visual design features of an information system (Karimov et al, 2011). In the socio-physical world, the presence of identifiers of social status such as the wearing of a police uniform, nurse's uniform, airplane pilot's uniform and the carrying of work identity cards can serve as a visual indicator of trustworthiness and convey attributes such as integrity and competence. Likewise, within the human-to-system relationship, a visual indicator such as the symbol of a key can be used as a visual feature to indicate a secured website. In a web information system, graphical design of a website could be a major contributing mechanism for an initial trust (Kim and Moon, 1998). Elements of visual design can portray emotional appeal, uniformity, aesthetics, and enhance the graphic look of a system.

Hu et al (2010) explains that extrinsic cues or features can provide information to a particular targeted user group. These features can produce either a positive or a negative influence on user perceptions of service quality and trustworthiness that can trigger users to respond either positively or negatively to a system. This agrees with the suggestion made by Kim and Moon (1998) that design features of an information system can have a positive impact on information system usage.

3. Perceived Usefulness of a System

This is an important determinant of a user's initial trust in an information system. It is a user's perception of the expected benefits of using a system (Hoehle et al, 2012). The more useful a user perceives a system to be, the more he or she would be inclined to use

it (Hoehle et al, 2012; Davis 1989). Kufaris and Hampton-Sosa (2007) hypothesised that perceived usefulness of an information system is positively related to initial trust. Additionally, Bhattacherjee (2001), in his study of online banking, found out that the success of an online banking system does not depend only on the subjective benefits that it brings but also on the level of trust that its users have in it because of its perceived usefulness. This is applicable not only to online banking, but also to other information systems.

4. Motivation

A user can be motivated by an incentive, inducement, desire, interest or aspiration to use a system. Researchers have argued that level of usage can be influenced by intrinsic and extrinsic motivation (Teo et al, 1999; Igbara et al, 1995; Sharma and Chandel, 2013). The extrinsic factors are perceived ease of use and perceived usefulness (Davis et al, 1992) while the intrinsic factors are enjoyment, fun and satisfaction (Teo et al, 1999). Users can use and establish an initial trust in a system not only because they derive benefit from it, but also because they enjoy using it.

There are some theories that show the significance of motivation to initial trust in systems. Davis et al (1992) applied two theories to find the factors that influence users' adoption and use of information systems. The first theory was the Motivation Theory and the second was The Technology Acceptance Model (Davis, 1993). The result showed that both intrinsic and extrinsic factors have significant impact on intention to use and actual use of an information system.

5. Reputation

A potential system user can be attracted to an information system because of good reputation. Sieber and Valor (2008) found that users more readily trust organisations that have agood reputation for well-established technologies and capabilities at an initial contact than those that do not. The result of an empirical study demonstrated that the reputation of an organisation has a positive impact on users' initial trust in that organisation's information system (Jarvenpaa et al, 1999). An organisation's reputation

takes time, energy and resources to build and is perceived to be worth protecting. Therefore, organisations prioritise protecting their reputation by keeping up standards and meeting targets in order to gain the trust of individuals that use their information systems. Most customers and stakeholders prefer to be identified with information systems of well-known and reputable organisations than newly established ones (Koufaris et al, 2007).

6. Information System Quality

Information Quality is defined as the degree to which an information system meets its intended aims and objectives (Poels andCherfi, 2006). A user can perceive if an information system is of high quality if the system exhibits the qualities he or she expects in a trustworthy system. A framework that explains the relationship between information system quality and information system success was developed by Delone and McLean (DeLone and McLean, 2003). A brief description of this model is discussed in the next section of this chapter but a mention of it here is included for completeness. A successful information system can be assessed in terms of its service quality, system quality and information quality. These elements affect users' initial trust in a system (Delone and McLean, 2002). If all the quality elements produce a positive influence on actual use and user satisfaction, then the user is likely to receive a positive net benefit and therefore feel positive initial trust. If not, the result would be a negative impact on initial trust.

7. Social Pressure

Social pressure from another person or group of people can cause a change in the thoughts, attitude, or behaviour of a system user. Social influence could come from personal referrals from friends, families, gangs and colleagues (Kim and Prabhakar, 2000). It can have a significant impact on a user's trust in a system at initial contact because the more positive the referrals the higher the likely initial trust in the system (Kim and Prabhakar, 2000).

Igbara et al (1995) hypothesised that social pressure has a direct impact on information system use. A user can decide whether to allow social pressure to influence his or her

behaviour or not. A study was conducted through an online social platform with 200 system users to find out the extent to which peer pressure can influence users' behaviour. It showed that users were more responsive to peer pressure if they consider their peers when making decisions to either trust an information system or not (Nouh et al, 2014).

2.4.2 Trust that Develops over Time

This section deals with trust that develops over time because of a user's continuing interaction with an information system. This form of trust by a system user is a significant contribution to an effective use of an information system. Trust develops over time as one accumulates knowledge and experience through continuing interaction with a system. While initial trust is an important factor for information system acceptance, the eventual success of an information system may depend more on its continued use (Bhattacherjee, 2001).

The continuing use of a system is the result of a series of decisions by an individual to use an information system repeatedly. It follows an initial acceptance of an information system. Information Continuance Theory is suited to study trust that develops after a user's repeated interactions with an information system (Bhattacherjee, 2001). Bhattacherjee (2001) integrated the Technology Acceptance Model (Davis, 1989) with the Expectation Confirmation Model (Oliver, 1977) to propose the Information Continuance Theory. The theory explains the underlying principle behind a user's intention to continue with the use of an information system. This principle explains that when a user uses a system for the first time, his or her expectations are either confirmed or disconfirmed. If his or her expectations are confirmed, then he or she can move on to continuous use of the system. However, if his or her expectations are disconfirmed, his or her negative experience with the system can affect his continuous use.

Users' continued use of a system is very important. Information system owners want to retain existing users and reduce users' switching behaviour (Adapa and Cooksey, 2013). Potential threats such as errors, identity theft, and privacy issues may cause a user to lose trust in a system after an initial trust and then re-evaluate their system use (Hoehle et al,

Goode, 2012). A system user can adjust his or her trust in a system over time and this adjustment could be triggered by favourable or unfavourable factors. Some of the factors that can influence a user's continued use of an information system are discussed below.

2.4.2.1 Determinants of Continuous Trust in an Information System

The factors that influenced initial trust, as discussed in the previous sub-sections are also applicable to continued system use. They are: propensity to trust, physical attractiveness of a system, motivation, perceived size and reputation of the organisation, information system quality, and social pressure (Gefen et al, 2003; Ridings, Gefen, and Arinze, 2002; Delone and McLean, 2003; Corritore et al, 2003). Additional factors affecting only longer-term use of information systems are discussed below.

1. User's Effectiveness

User's effectiveness is defined as the accuracy and completeness with which a system user is able to achieve certain goals with an information system within a particular time limit (Turpin andHersh, 2001). A user's effectiveness can be measured by the number of tasks completed and the time taken to complete each task (Su, 2003). The effort a user expends to gain sufficient experience of critical features of a particular system can influence his or her continuous use of the system as the user becomes experienced and familiar with the system's features.

2. Prior Experience with Information System

A user's previous experience with an information system can affect his or her continuous use of same system. Most continuous users have already passed through the initial trust phase of information system usage and have developed continuous trust based on their previous experiences with the same system (Hoehle et al, 2012). A user can accumulate direct knowledge about a system through his or her positive experiences with that system. These experiences can reduce uncertainty and fear and generate increased understanding, and trust in the system. Following the assumptions of the Information Continuance Theory mentioned earlier in this section (Bhattacherjee, 2001), users hold positive or

negative expectations prior to adopting a particular system. After the user has initially trusted the system enough to start to use it, the presence of bugs, system crashes, errors or other negative experiences that develop over time may produce a negative effect on their continuous trust in that system. On the other hand, if a user has a positive experience, then trust increases with subsequent use and his or her perception of system trustworthiness increases with time and may positively be transferred to other potential users who would also have their perception of the system's trustworthiness enhanced.

2.5 Theoretical Frameworks

Several information systems theories and models have been proposed over the years. They explain, analyse, predict, and shape information system research, design and development (Marcus and Robey, 1988). They include: Social Network Analysis (Scott, 2000) Social Cognitive Theory (Bandura, 2001), Technology Acceptance Model (Davis, 1989), Information System Success Model (Delone and McLean, 2002), Information System Theory of Organisation (Fairbank et al, 2006), and Soft System Theory (Checkland, 1981). Others are Integrative Model of Organisational Trust (Mayer et al, 1995), The Commitment Trust Theory (Morgan and Hunt, 1994), The Witness Based Theory (Liu et al, 2012; Du et al, 2003). Other frequently used ones are; The Expectation Confirmation Theory that was propounded by Bhattacherjee (2001), The Thriving System's Theory by Waguespack (2010) and The Theory of Planned Behaviour by Ajzen et al (2002). Few of these theories and models focus on information system's trustworthiness.

Two of these models and a theory have been adopted for use in this thesis to help explain the dynamics of system trustworthiness and meet the research aim of finding the factors that can enhance users' trust in information systems. The first is the Witness-based Trustworthiness Model (Liu et al, 2010, 2012) that deals with systems trustworthiness in relation to a user's experience and the witness of other users who have had experiences with same system. The second is The Thriving Systems Theory (Chin and Older, 2010;

Waguespack, 2010; Waguespack and Schiano, 2013; Waguespack et al, 2014) that focuses on designing a trustworthy system based on the expectations of the users and the stakeholders. The third is The Delone and McLean Success Model (Delone and McLean, 2002; Elpez and Fink , 2006) that relates the quality dimensions of an information system to information system success. These were adopted because they deal directly with information system trustworthiness that relates to the objectives of this thesis. Additionally, they can serve as a useful framework for understanding trust in information systems. These theories are discussed briefly in this chapter.

2.5.1 Witness-Based Trustworthiness Model

The Witness-based Trustworthiness Model uses personal and public testimonies to model trustworthiness where the trust sensitivity of a user is a function of someone's own experience and a witness of other users' experiences (Zhang and Cohen, 2006; Liu et al, 2012). It is not about system's design, but modeling trustworthy perception and discusses what makes a system trustworthy from the user's perspective of system's trustworthiness. In this model, the level of information system trustworthiness is based on a witness testimony and a user's experience with a system, which are then evaluated to determine if they meet an acceptable level required by the user to trust the system (Liu et al, 2011; Yu, Shen, and An, 2012). A basic illustration of this model takes the following form: Assume there are N service providers $\{P_1, P_1, \ldots, P_N\}$ of social media seeking to operate in a reputation environment. Now, supposing that a user U is evaluating a service provider's $P_i'\text{s}(1 \trianglelefteq i \trianglelefteq N)$ trustworthiness. To make the decision regarding $P_i'\text{s}$ trustworthiness, U may request evaluations from other users who have used $P_i's$ services. These users are called witnesses W. The problem, therefore, is how U can combine their own experience and W testimonies to form a trust perception T. In this example, trustworthiness of a social media website can be thought of as a linear combination of $U's$ personal experience and Ws' testimonies related to P_i. Assuming U and W interact with social media, P_i at time t, the trust perception T can be specified as a linear regression: $T_t = U + \beta_1 W_t$ where U and W represent user and witnesses respectively. β_1 represents testimonies from witnesses and can be positive or negative. Additionally, U and β_1 can

be interpreted as trust propensity (Liu et al, 2012). This specification implies that the trust perception is determined by a user's initial level of trust plus trust perception formed from witnesses' testimonies. The implication of this model is that a positive trust perception from witnesses' experiences is required for a user of a social media system, say Facebook, to trust and keep using it.

The Witness-based Trustworthiness Model highlights some important factors that influence trust. For example, consider eBay and Amazon, online-based commercial transaction providers. Exchange of goods under these platforms involves more uncertainty and risk than traditional shopping at a physical location. In this business model, a consumer cannot physically check the quality of a product before making a purchase, or monitoring the safety and security of sending sensitive personal and financial information. Since this business model involves participants whose behaviours and motives may not be consistently predicted, witness-based trustworthiness, suggests that the trust perception of eBay and Amazon are formed based on the combination of a consumer's experience and the experiences of other consumers who had used eBay and Amazon. The user seeks the witness testimony because of the uncertainty and the risk involved in the relationship. Risk and uncertainty are known preconditions for trust (Kim and Prabhakar, 2000; Corritore et al, 2003; Luo et al, 2010).

An interesting implication that emerges from this theory is that both eBay and Amazon can improve their dependability by promoting product availability and diversity, consistency, and fairness in handling complaints. The Witness-based trustworthiness model has been applied by Zacharia and Maes (2000), Yu and Singh (2002, 2003, and 2007) and Liu et al (2012) to evaluate information system trustworthiness where users combine personal ratings and external ratings based on testimonies from witnesses to determine a trustworthy system. The consensus is that its application is relevant in modelling trustworthy perception in information systems, where users are interconnected and witnesses can be a significant factor in rating system trustworthiness (Yu et al, 2012).

2.5.2 Thriving Systems Theory (TST)

Thriving Systems Theory (TST) is an information systems theory related to trustworthiness based on the systematic integration expectations of all stakeholders (Waguespack and Schiano, 2013). Managing expectations from information systems becomes the most important aspect of their design and implementation in an ever increasing globalised and digital society that can be further influenced by social, industrial, medical, as well as scientific, economic, political, and national security pressures (Anderson, 2001; Waguespack, 2014). Therefore, TST explores how the expectations of information system stakeholders can be optimised in service delivery to improve trustworthiness. Stakeholders are individuals, groups, and users who get involved in the activities of a system (Spitzek and Hansen, 2010). Initially, system development focused more on the socio-technical aspect and tended to neglect users (Fitzgerald et al, 2002). Moreover, there is consensus among researchers that one of the major determinants of system failure is a lack of user involvement in system development (Bimrah et al, 2007; Boehm, 2006; Yeghini, 2009). Therefore, meaningful user and stakeholder involvement play an important role in system development because they define system requirements in a real world situation and ensure that their requirements, alongside technical specifications, are met (Butt and Ahmad, 2012).

Furthermore, the TST postulates that stakeholders' trust in information systems is driven by a combination of two factors: the users' implicit expectations and responses to those expectations, which can enhance their experience (Chin and Older, 2010). Therefore, trustworthiness in an information system results from the strategies and channels through which users' expectations are met and how the users perceive and rate them, which in turn determines trustworthy behaviour (Waguespack, 2014).

Thriving Systems Theory (TST) as explained above is fundamental in understanding the perception of trust in information systems (Pries-Heje et al, 2014). To demonstrate the application of this theory, an online world can be considered. In the online world, there are two possible relationships between trustors and trustees: 1) individual-to-individual

trust relationships mediated through information and communication technology and 2) human-to-system relationships. An illustration of TST, is taking the example of individual-to-system trust relationships, say, the Facebook website as the information and communication technology that mediates between users.

In this case, trust represents an attitude of confident expectation in a state of risk that one's vulnerabilities will not be exploited; expectancy held by an individual that the word, promise, verbal or written statement of another individual can be relied on. In our Facebook example, the risk involved is that prospective friends are not who they claim to be in their profiles, which may lead users to form relationships with inappropriate individuals. In these circumstances, the problem facing an individual user is how to assess correctly the trustworthiness of other users. Thus, the question that arises is what kind of information is relevant for users to improve their chances of making accurate decisions regarding others' trustworthiness? However, in this example, users are vulnerable because that they must rely on the information available on the website to form friendships or relationships.

2.5.3 The Delone and McLean Information System Success Model (D and M IS Success Model)

The quality of an information system is critical to understanding the effect of trustworthiness on information system success. The D and M IS Success Model is a standard for specification and justification of the measurement of the dependent variable in information system research (Delone and McLean, 2002). The independent variable is referred to as the exploratory variable (for instance, a school portal, an e-commerce website) while the dependent variable is the response variable (they include the attributes of the quality dimension of an information system for instance, accessibility, predictability, security, ease of use). The response variable depends on the independent variable in any given circumstance. The independent variables are the different information systems and the dependent variables are the quality dimensions of

information systems (Urbach and Muller, 2012). The attributes that constitute the quality dimension of a system can change depending on the information system concerned. Moreover, each system has different aims and objectives because they perform different functions.

The D and M IS Success Model was published in 1992 by Delone and McLean and was revisited and re-formulated in 2003 based on changes in the role of management and information systems (Delone and McLean, 2002). The model has been used successfully in research and has been validated, challenged, modified and tested (Wang and Liao, 2008). Although information systems have progressed a lot in the past few years, this model is considered one of the most up to date and useful models and is currently widely used in research because of its richness and relevance.

In 1992, Delone and McLean proposed that both information quality and service quality, either jointly or singly affect both information system use and user satisfaction. The model identified six interrelated dimensions of information system success. The system quality, information quality, service quality, use, user satisfaction, and individual impact (Wei et al, 2009).

As a follow-up to this model, DeLone and McLean (DeLone and McLean, 2003) suggested an update. “Service quality” was added to the initial proposal to show the importance of service quality in the success of any information system. “Intention to use”, was also added while “Individual Impact” and “organizational impact”, was replace with “net benefit” (Delone and McLean, 1992; DeLone and McLean, 2003). Therefore, the updated model includes information quality, system quality, service quality, use (intention to use), user satisfaction and net benefit (DeLone and McLean, 2003).

The D and M IS Model has been adopted by several information system studies. Some of the studies focused on different factors that affect the success of information systems while others on the need to develop models based on the D and M IS Model (Cenfetelli et

al, 2009, Wang and Liao, 2008). The D and M IS Model has an impact on this study. Quality represents an inherent and essential feature that determines trustworthiness. The notion of trust can be defined in terms of quality and can be used to assess trustworthiness (Lampe et al, 2003). Similarly, a trustworthy system can be considered a mark of high quality. As a result, The D and M IS Success Model has a significant impact on the attributes of information systems trustworthiness derived for the purpose of this study.

2.6 Chapter Summary

The literature reviewed in this chapter started with research on the general concept of trust and then focused on trust in information systems. To give more insight into trust and trustworthiness, two models and a theory were investigated.

This chapter opened with discussions on the importance of trust in various relationships. Trust was seen to be inevitable at home, in the work place, in business, politics, commercial activities, and in most human activities. The concepts of trust were discussed from various dimensions. The first concept came from the bases of trust in any trust relationship, which includes institution-based trust, knowledge based trust, characteristics based trust, affective based trust and cognitive based trust (Mayer and James, 1999; Bandura, 2001). This was followed by investigating the various elements that determine the nature of trust. Amongst those elements, four were found to be inevitable in every trust relationship. Additionally, they were commonly mentioned in most of the literature reviewed and they fit well with the objectives of this thesis. These four elements were found to interrelate with each other in every trusting relationship. They are expectation, reliance, risk and vulnerability. Expectation was explained to be a positive anticipation of an outcome (Faily and Flechais, 2014; Lancton and Wison, 2007), while risk taking was defined as engaging in a behaviour that can have an undesirable and potential harmful outcome (Kim and Prabhakar, 2000). Reliance was seen to be an act of dependence on an object of trust (Josang and Presti, 2004), while vulnerability was discussed as the state of

being exposed to the possibility of being harm either physically or emotionally (Bidner and Jackson, 2013).

Research on trust was seen to be increasingly common across many areas such as organisation, management, politics, psychology, business, sociology, law and medicine. Trust from the social science perceptive received more attention in the chapter because this relates more to the concepts of this thesis. The psychological view of trust investigated the internal dynamics of trust in humans (McKnight and Chervany, 2002), based on emotions, attitudes, beliefs, and expectations. In the sociological view, trust is between individuals and the social factors around them (Fu, 2004). Individuals depend on each other for the services they are able to provide. In economics, trust is cognitively based and stems from a calculative-based behaviour where an individual expects an outcome from an object of trust (Castelfranchi et al, 2006). Trust with respect to information system is largely centred around these three perspectives on trust. It is a form of human-to-system relationship and has been researched widely as a form of interpersonal trust (Hassan, 2010).

Generally, Chapter 2 viewed trust in information systems as an expectation a user has in the future performance of a system based on the evaluation of a system's characteristics. Subsequently, the chapter came up with a working definition that defines trust as the willingness of a user to be vulnerable to the actions of an information system based on the expectations that the information system will behave satisfactorily irrespective of monitoring or controlling it. In a human-to-system relationship, trust is necessary and is centred on the understanding of an individual's behaviour in the information system domain (Dirks, 1999).

The fundamental difference between the human-to-system trust relationship and human-to-human trust relationship is that systems are human-created artefacts and have a limited range of behaviour compared to humans in the way that they respond to expectations (Constantine, 2006; Riegelsberger et al, 2005). They are limited to the choices they can make. The similarities between them are that both can reciprocate trust. Information systems can also perform a mediating role between humans by passing information from

one human to another and acting as a bridge. It was pointed out that when a person trusts a system, trust is automatically transferred to the individuals behind the scene who are not visible to the human eyes such as the system designers, operators, and maintenance engineers.

There are certain manifestations of trust that can affect the adoption and continuous use of systems. They are initial trust and trust that develops from continued use of systems. Initial trust develops when a user visits or explores an information system for the first time. There are certain factors that determine initial trust which include a user's propensity to trust, the physical design of a system, perceived usefulness, motivation, reputation, perceived size of the organisation that operates the system, information quality and social pressure. The trust that develops over time from the continued use of a system can be influenced by these same factors and additionally, a user's growing knowledge of the system and ability to use it effectively to derive benefit.

The latter part of this chapter discussed two information system models and a theory that deal specifically with information system trustworthiness from the users' perspective. This was to shed more light on the concept of human-to-system trust and perceptions of trustworthiness. The theory considered was the thriving system theory and the models were the witness-based trustworthy model and the Delone and MacLeans' Information System Success Model. The witness-based model evaluates the trustworthiness of an information system based on ratings from other system users and one's own experience with same system. A user's decision to trust depends on whether the ratings meet the acceptable level that he or she requires to trust the system (Liu et al, 2012). The thriving system theory explores how the expectations of all the stakeholders of a system can be optimised to improve trustworthiness (Waguespack, 2010). The stakeholders include the system users and everyone involved in the activities of a system.

The Delone and MacLean IS Success Model shows that the quality of an information system is critical to understanding the system's trustworthiness (Delone and McLean, 2002). The six dimensions reviewed are system quality, information quality, and service quality, use and intention to use, user satisfaction and net benefit. In the course of the

review, a strong relationship between the quality dimensions of this model and system's trustworthiness was identified. The Delone and MacLean IS Success model gives an explanatory framework and a guide to achieving the main aim of this research.

The next chapter will investigate what attributes enhance a system's impression of being trustworthy. It will also use the D and M as the theoretical base for this thesis and will explain the relationship between the quality factor of D and M IS model and the information system trustworthy attributes.

CHAPTER 3

INFORMATION SYSTEM TRUST ATTRIBUTES AND THE RESEARCH MODEL

3.1 Introduction

This chapter investigates some trust attributes that can enhance user perceptions of information system trustworthiness. This comes after looking at the concept of trust from a multidisciplinary perspective and trust in information system as a form of human-to-system relationship. This chapter argues that user perceptions of trust plays an important role in the adoption and continuous use of an information system. A number of studies and theories were employed to explain this. They present ways of understanding, behaviours and situations in human-system trust relationship. Studies from the previous chapter revealed that users might not perceive the trustworthiness of an information system, as they ought to because of not possessing suitable attributes of trustworthiness such as secure, reliable and available. Users may use an essential system they do not perceive trustworthy just to meet a need. Consequently, the current chapter investigates the attributes of trustworthiness that can enhance a system's trustworthiness. It also answers the research question of "how can trustworthy attributes that can promote user trust perceptions in information systems be determined?"

Attributes of trustworthiness are the features possessed by an information system that makes it trustworthy (Van-den-Hoof et al, 2013). Studies may vary in terms of identifying trust attributes. Each researcher's focus is on the attribute that connects to his or her chosen field of study. Additionally, different attributes may be important to different types of research. There is agreement among some researchers that system trustworthiness is linked with system quality (Oinas-Kukkonen and Harjumaa, 2008; Kelton et al, 2008; Stracke and Hildebrandt, 2007). Therefore, most of the attributes of information system trustworthiness used for this thesis will come from the review of some of the major quality frameworks and models. The attributes derived will be

compared with the quality factors of The D and M IS Success Model because of the relationship of its quality dimensions with trustworthiness. Additionally, it is one of the most accepted information system models that has been tested and tried over the years by other researchers.

3.1.1 Trustworthiness and Trust Perceptions of Information Systems

Different researchers have used the word "trustworthiness" and "trust perceptions" interchangeably. To distinguish between the two terms in the context of this study, trustworthiness of an information system indicates when trust related features of a system are available and can be accessed by users. Trust related features are assessed by users in terms of the degree of a system's functionality, availability and compliance with accepted security practices. Trust perception is a belief-based conceptualisation of trust (Buttlner andGoritz, 2007). It is an indication of the way in which an information system is understood or interpreted by a user and can be built on the opinion held by a user on how an information system seems to be (Atkinson and Clark, 2013). Trust perception is futuristic. Mayer and James (1999) developed a model whereby perceived trustworthiness encompasses ability, benevolence and integrity. They conclude that a user's belief in these three dimensions of trustworthiness could affect his or her willingness to trust a system. There is an agreement among researchers that trust perception is a belief-based conceptualisation of trust (McKnight and Chervany, 2002; Jarvenpaa et al, 2000; Gefen, 2000).

3.1.2 The Relationship between Quality and Trustworthiness

Quality is very important when considering system trustworthiness (Stracke and Hildebrandt, 2007). Quality is not the same as trustworthiness, but can enhance trustworthiness. This agrees with a lot of researchers' views of quality as an enabler of trustworthiness and as a standard to assess trustworthiness (Oinas-Kukkonen and Harjumaa, 2008; Kelton et al, 2008; Stracke and Hildebrandt, 2007; Buttlner and Goritz, 2007; Meng et al, 2011). Most of the literature discussed in this section shows that there is a strong relationship between quality factors and trustworthiness.

From a user's perspective, an information system can be considered trustworthy if it possesses the qualities that a user considers trustworthy (Camp, 2003; Aris et al, 2011; April and Pather, 2008; Camp, 2003; Hussain et al, 2007). Moreover, information systems can equally exhibit their trustworthiness through quality attributes (Aris et al, 2011; Brajnik, 2001: Meng et al, 2011). Considerable efforts have been spent on designing and developing systems to make them trustworthy by focusing on quality factors (Shank and Corbit, 1999).

Quality is a concept too difficult to define and has no common agreed definition (Parasuraman et al, 1985; Alkhattabi et al, 2010), but quality can be defined as conformance to requirement (Crosby, 1980), fitness for use, (Lofgren and Witell, 2005), efficiency (Demings, 1986), keeping to standards (Taguchi, 1992), reliability (McCall, 1977), degree of excellence and of meeting expectations (Poels and Cherfi, 2006; Parasuraman et al, 1985). Each and all of these definitions explain the different approaches to quality that can inspire trust.

3.2 Quality and Trustworthy Attributes

To obtain a comprehensive list of quality factors that constitute attributes of trustworthiness, the views of different researchers are considered using quality frameworks and models, because of the relationship between quality and trustworthiness. The quality frameworks and models cited in this section are limited to user perspectives because users are the primary focus of this thesis. Wang and Strong (1996) proposed a framework for the classification of data quality with the following quality dimensions: believability, accuracy, objectivity, timeliness, relevancy, completeness, appropriate amount of data, interpretability, concise representation, consistency, accessibility and access security, response time, availability, verifiability and consistency. This framework has been used in a lot of information system research (Lin et al, 2007; Alkhattabi et al, 2010).

Gertz (1996) proposed a framework with timeliness and completeness of information for the purpose of database integration. A framework was proposed for information quality

in a web environment and it consisted of accuracy, ease of navigation, objectivity, orientation, currency, and authority (Alexander and Tate, 1999). Redman (1997) proposed a quality framework as a guideline that can be used to analyse and improve information quality within business processes in organisations. It includes privacy, presentation, content, and quality of values. Shank and Corbit (1999) proposed a semiotic-based quality framework for web-based information systems with the following attributes: consistency, accuracy, completeness and usefulness. Lin et al (2007) used a data quality framework that categorised quality attributes into four main parts: accessibility, contextual, intrinsic and representational for engineering asset management.

Some quality models constitute trust attributes just like some quality frameworks do. Quality models are defined as a set of characteristics and the relationship between them that provide the basis for the specification of quality requirements and the evaluation of quality (Singh, 2013). This section considers a few quality models that contain some of the attributes that may be needed for the purpose of this thesis. Davis (1989) in his Technology Acceptance Model identified ease of use and usefulness as the major determinant of acceptance and usage of information systems. Parasuraman et al, (1985) in their model for service quality came up with ten service quality attributes and they are credibility, communication, responsiveness, reliability, tangibles, security, courtesy, competence, access and understanding. Johnson (1995) distinguished 11 determinants of service quality constructs and they are appearance, availability, cleanliness, comfort, communication, competence, courtesy, friendliness, reliability, responsiveness and security. Loiacono et al (2002) proposed "Webqual", a website quality measure with the following dimensions: response time, visual appeal, information fit to task, interaction, trust, integrated communication, intuitiveness, design, innovativeness, emotional appeal, business process, substitutability.

Parasuraman et al (1985) developed a quality model with the following dimensions: competence, access, courtesy, communication, credibility, security and physical appearance. Gronroos (1984) developed a quality model with ease of use, physical appearance, linkage, structure layout, content, reliability, efficiency, support,

communication, security and incentives. Heywood-Farmer (1988) developed a conceptual model of service-quality with the following attributes: location, layout, décor, size, facility, reliability, process flexibility, timeliness, speed, communication, courtesy, warmth, friendliness, and tact attitude, tone of voice, dress, neatness, politeness, attentiveness, anticipation, handling, complaints, and problem solving. Khan et al (2002) proposed quality benchmark model that consists of 16 quality dimensions. They are accessibility, appropriate amount of information, believability, completeness, concise representation, and consistent representation, ease of operation, free of error, interpretability, objectivity, relevancy, reputation, security, timeliness and understandability. McCall (1977) developed a quality model with reliability, efficiency, integrity, maintainability, usability, portability, reusability and interpretability. The Boehm Model is similar to the McCall Model with more quality factors added. They are clarity, modifiability, documentation, resilience, understandability, validity functionality, generality and economy (Boehm et al, 1979).

This section presents a comprehensive list of quality factors that convey trustworthiness of information systems from a review of several papers. Most of the authors of these papers analysed their quality factors from both system designers and users perspectives. Therefore, the quality factors captured were from both the system designer and user perspectives. In the next section, an attempt will be made to reduce the quality factors to factors that relate only to a user's perspective of trustworthiness.

3.3 The Trust Attributes

In the previous sub-section, some quality factors that enhance trustworthiness were identified from quality frameworks and models. Most of the authors of these papers analysed these factors from both the designer and user perspectives. The quality factors that come from the designer perspectives that do not match with quality in use from system user perspectives are eliminated e.g. modifiability, guidance, advice, location, validity, innovativeness etc. The quality in use attributes that come from the user perspective are adopted and are used for further studies as trustworthy information

system attributes e.g. accessibility, accuracy, predictability etc. Quality in use is the user perspective of quality when using a system (Poels and Cherfi, 2006).

Word analysis was performed to eliminate repetitive words in order to avoid overlapping of concepts. Word analysis is a strategy that can be used to break down words into their smallest unit in order to figure out their meanings. It is the ability to approximate the meanings of words (Xiong and Litman, 2013). A study was carried out within this chapter to examine every quality attribute. Each quality attribute was arranged into different word groups that have similar meanings based on their interpretation. A word or phrase was extracted from each list as a representative of that word group (Shown in Appendix A1 and A2) For instance, understandability, clarity, communication are grouped as a "clarity of information" attribute. Speed, responsiveness and fastness are grouped as "fast response time". Navigation, ease of use and flexibility are grouped under "easy to use" attribute. After completing the word analysis, 14 trust attributes were realised from the quality frameworks and models. These 14 attributes represent the trust attributes that users look for in trustworthy systems. They are: accessibility, accuracy, attractive appearance, availability, clarity of information, detailed operation information, ease of use, fast response time, reputation, predictability, privacy, security, verifiable information, and well known and widely used.

3.3.1 Justification of the Attributes of Trustworthiness

A wealth of knowledge and experience in information system development and management has accumulated globally over the past three decades. However, the inability to understand and model trust in the system design process constitute a major problem in information system development (Bimrah et al, 2007). To model trust in the system design process, the first step taken by this research is identifying the factors that can enhance user perceptions of information system trustworthiness. These factors can be obtained from quality models and frameworks because these models and frameworks have been evaluated, assessed and managed in information system settings over the years.

Additionally, they have been used as evidence for standards, identifying good practice and the identification of areas that require improvements in information system management.

3.3.2 Attributes of Systems Trustworthiness and their Interpreted meanings

This section discusses the 14 attributes gathered from empirical studies and their interpreted meanings.

- **Accessibility:** Defines whether an information system is capable of serving requests specifically to users with limited capabilities. An accessible system is aimed at addressing the needs of people with visual impairment, mobility, auditory, seizures, developmental disabilities, the aged etc. (Lazer et al, 2004; Huang, 2003; Jaeger, 2006)
- **Accuracy:** This defines the correctness of information or freedom from error and mistakes (Yang, 2011; Hasselbring, 2006). Gelman (2004) pointed out some causes of system errors. They include the lack of technical knowledge and skills, faulty input devices, wrong methodologies and strategies by designers, developers, marketers and operators.
- **Attractive Appearance:** Defines when an information system is appealing to its users because of its pleasant appearance (Karimov et al, 2011). Such as good quality graphic and visual design (Kim and Moon, 1998).
- **Availability:** Defines the ability of an information system to deliver services whenever it is required (Zhao et al, 2010). Availability is not only limited to information and data availability, but also includes availability of system functionalities (Petter, 2008; Martin and Khazanchi, 2006).
- **Clarity of Information**: Information clarity is information presented in a manner that can be easily understood by system users (Meng et al, 2011). Information that is clearly defined can increase user perceptions of trustworthiness, and prevent errors and faults that may lead to system failure (Lee et al, 2000; Meng et al, 2011; Dzindolet et al, 2003).

- **Detailed Operation Information**: This defines how an information system operates (Lee and See, 2004). Such information may include company information, security, and any form of information about the purpose, process and performance of a system. Such information may lead a system user to a safe, smooth and secure system operation (Shelat and Egger, 2002).
- **Ease of use:** Ease of use reflects how simple an information system is for users to use (Igbaria et al, 1997). It includes ease of searching, ease of navigation, ease of interaction, ease of transaction, easy to learn, easy to manage and simplicity (Nelson and Todd, 2005; Igbaria et al, 1997; Belanger et al, 2002; Karimov et al, 2011).
- **Fast Response Time:** This refers to response and display rate (Khasawneh et al, 2003). Long delays during interaction with an information system can be distracting and frustrating and may lead to waste of efforts leading to user dissatisfaction with system performance. Users prefer systems that respond speedily to their requests (Moorman et al, 1993).
- **Good Reputation:** Represents publicly held perception of an information system (Fuller et al, 2007). Empirical studies show that users are more likely to trust a system that has good reputation than those that do not (McKnight and Chervany, 2002; Jarvenpaa et al, 2000; Liu et al, 2012).
- **Predictability**: This determines the degree to which the future behaviour of a system can be anticipated (Lee and See, 2004: Hasselbring, 2006). It is evaluated by the consistency of recurrent behaviours (Yang, 2011).
- **Privacy:** This is defined as the absence of unauthorised disclosure of a system user's information (Hasselbring, 2006). Privacy issues arise when users are prompted to input their personal information details such as credit card numbers, bank details, phone and house numbers. If there are violations to privacy, users may avoid such systems in the future (Culnan and Armstrong, 1999).
- **Security**: Security involves the use of policies, procedures and technical measures for the prevention of unauthorised access, theft, leakage or physical damage to an information system (Marsoof, 2008; Rong, 2013; Yang, 2011; Hasselbring, 2006).

If users perceive a system as having good security controls, it decreases their perception of risk, and increases trust in the system (Beebe et al, 2008).

- **Verifiable Information:** Verifiable information is checking that information obtained from an information system is true (Elgort et al, 2008). Verification of data aims to reduce the risk of data inaccuracy (Kumar et al, 2014).
- **Well Known and Widely Used:** Well-known and widely used systems are popular and easily recognised *(*Muir, 1994; Muir and Moray, 1996; Corbitt et al, 2003; Gross and Acquisti, 2005). They are familiar and users visit them often. Examples are Facebook, Twitter, LinkedIn, Myspace, Pinterest, Instagram, Yelp, Tumblr, and YouTube etc. (Gross andAcquisti, 2005).

3.3.3 The potentials for overlapping attributes

Earlier in this chapter, 14 attributes that can enhance users perception of information system trustworthiness were investigated. Some of these attributes seem to be overlapping in some ways. This sub-section gives a careful analysis of the slight differences that make them distinct despite their similarities. The attributes that look similar, but are distinct in specific characteristics are: accessibility and availability, accuracy of information and verifiable information, good reputation, well known and widely used attributes.

The major difference between accessibility and availability is that accessibility considers users with various disabilities or impairments that can hinder or negatively impact their ability to make imputs or perceive outputs during system use. Examples are hearing loss, deafness, blindness etc. Availability is the proportion of time a system is in functioning state for all intended users (Jaeger, 2006; Petter, 2008). Accuracy is a state of being correct or precise while verifiable information is checking if information complies with requirements in terms of completeness, consistency and correctness (Kumar et al,, 2014; Yang, 2011). Information may be accurate but a user may not be able to verify it.

A system may be well known and widely used but lack good reputation. A user may be fond of using a particular system simply because it is widely used by the public. Such systems may not necessarily have good reputation for trustworthiness e.g social networking sites. On the other hand, systems that have good reputation can also be familiar with users. The difference is that they are known for having specific skills or characteristics that are trustworthy e.g, Amazon and Wikipedia (Gross and Acquisti, 2005; Liu et al, 2012).

3.4 The Theoretical Background and the Research Model

In this section, the theoretical base for information system trustworthy attributes is established using the D and M IS Success Model and some prior information system success studies. D and M IS Success Model is one of the models that were presented as a theoretical base for this research in chapter two. The other two were The Witness-based Trustworthy Model and The Thriving System Theory. The models and theory were used to explain the dynamics of system trustworthiness. The Witness-based Trustworthy Model uses the testimonies of other individuals who have used an information system with an individual's own experiences gathered from interpersonal relationship with same system to assess the system trustworthiness (Zang and Cohen, 2006). The Thriving System Theory uses expectations of all the stakeholders of a system and includes the users to assess its trustworthiness.

Although the models and theory are beneficial to this study, we focus on the D and M IS Success Model because of its comprehensive framework for measuring quality. Its quality factors have remarkable impact on information system trustworthiness because trustworthy issues include quality issues (Delone and McLean, 2004; Iivari, 2007; Baraka et al, 2013; Gorla et al, 2010). The D and M IS Success Model gives a more detailed explanation of user expectations than the other two theories. In addition, there is a strong relationship between the quality dimensions of the D and M IS Model and

trustworthiness. Therefore, the D and M IS Success Model is more suitable for use as the theoretical base for this thesis.

3.4.1Delone and McLean Information System Success Model (D and M IS Success Model) (Delone and McLean, 2004)

This section discusses the D and M IS Success Model and links it to information system trustworthiness. The D and M IS Success Model is one of the most updated and widely cited models in information system research and is therefore up-to-date. It is used to explain or measure information systems success (Chumchalao and Naenna, 2013; Delone and McLean, 2004). The first primary objective of the D and M IS Success Model was to synthesis previous research that involved information system success into a more coherent body of knowledge because information system success was ill defined due to its complex and multi-dimensional nature (Deloneand McLean, 1992). The second objective was to provide guidance for future researchers (Delone and McLean, 1992). To achieve these objectives, Delone and McLean identified some critical success factors that originated from Shannon and Weaver's Theory of Communications, Mason's Information Influence Theory and Empirical Management Information System's (MIS) research studies from 1981-1987 (Shannon and Weaver, 1949; Petter et al, 2008; DeLone and McLean, 2003).

Shannon and Weaver's Theory of Communication characterises communication as a systemic process that includes the sender, the message, transmission, noise, channel, reception and receiver (Shannon and Weaver, 1949). It has three levels of operation: the technical, semantic, and effective levels. The technical level of communication defines accuracy and efficiency. The semantic level concerns the success of the explanation and interpretation of the intended meaning by the receiver, and the effective level defines the effect of the information on the receiver (Alshibly, 2014; Shannon and Weaver, 1949). The second theory is Mason's Information Influence Theory, which characterises a form of conformity that occurs when a person turns to another with the intention of obtaining information (Mason, 1978). The Original D and M IS Success Model was postulated based on the process and the causal considerations of these two theories.

Delone and McLean, (1992) analysed over one hundred empirical studies in addition to the two theories; Shannon and Weaver Communication Theory and the Mason's Information Influence Theory, to arrive at six major information system factors namely: system quality, information quality, use, user satisfaction, individual impact and the organisational impact. The original M and D IS Success Model is shown in figure 3.1a. After this particular study, they concluded by calling for further development and validation of their model. A brief explanation of the original and updated models was given in chapter 2.

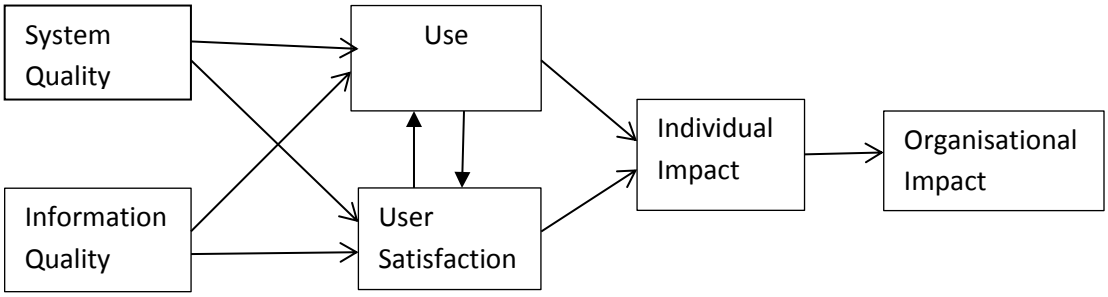


Figure 3.1a: The original Delone and McLean IS Success Model (Delone and McLean, 1992)

The updated D and M IS Success Model was based on the empirical and theoretical contributions of researchers who tested, discussed and criticised the original model following the call by Delone and McLean between 1992 and 2002, for its further development and validation (Delone and McLean, 2002). The updated D and M IS Success Model is shown in figure 3.1b. While the majority of the researchers empirically and explicitly tested the relationships among variables identified in the model, a minority of researchers criticised the model and suggesting that it had major gaps (Seddon, 1997; DeLone and McLean, 2003).

The updated D and M IS Success Model attracted high interest from researchers and provided a platform for a large number of success frameworks (Seddon, 1997; Garrily

and Sanders, 1998; Rai et al, 2002). The updated model is made of system quality, information quality, service quality, use and intention to use, user satisfaction and net benefit.

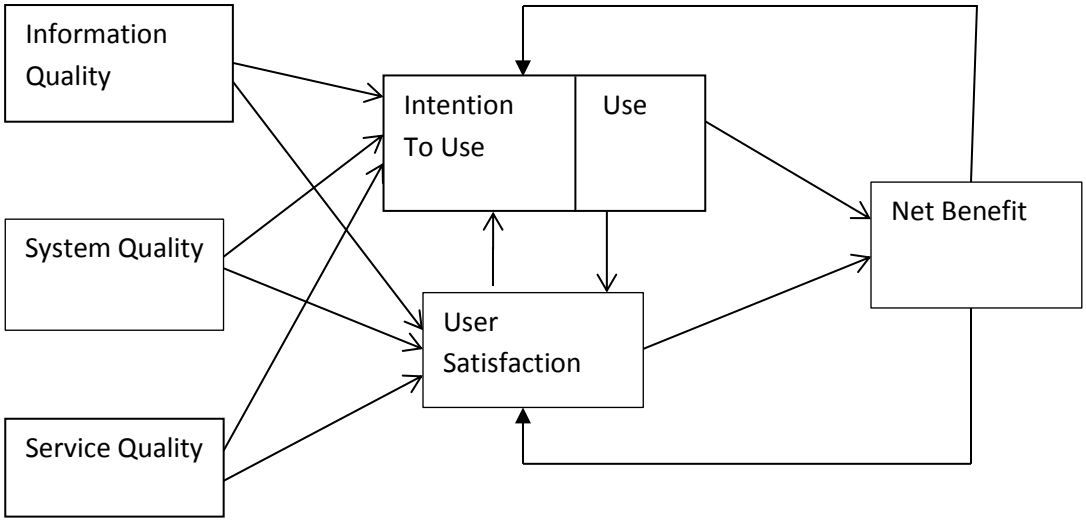


Figure 3.1b: The updated D and M IS Success Model (Delone and McLean, 2004)

3.4.2 The Six Dimensions of the Updated Delone and McLean IS Success Model (Delone and McLean, 2004)

As literature on D and M IS Success Model is large and multidimensional, its coverage can be very wide and unending due to the continued production of new studies. Therefore, this section discusses some empirical studies that integrated the components of D and M IS Success Model. Additionally, it analyses how the quality dimensions of this model are linked with trustworthiness.

- **Information Quality**

Information quality measures the quality of information produced by an information system. It considers the fitness of information for use (Nurse et al, 2011). There is consensus among researchers that information quality has a positive effect on information system usefulness (Davis, 1993; Petter et al, 2008; Kraemer, Danzinger et al, 1993). If information quality is low, a user is likely to have less confidence in the information delivered and therefore will protect his or her trust from being damaged. Elements for measuring information quality include verifiability, clarity, detailed information, helpfulness, consistency and completeness (Rababah and Masoud, 2009; Zaied, 2012; Wei et al, 2009).

The importance of information quality can be seen as demonstrated by various researchers. Sharkey et al (2010) investigated the effect of quality on e-commerce success. The result showed a significant relationship between information quality and system quality. Gorla et al (2010) investigated the critical variables that assist chief information officers to devise effective IT improvement strategies within an organisation. The result showed that information quality is the most influential variable that can assist chief information officers to perform successfully. Nicolaou and McNight (2006) carried out a study on the effect of information quality on the success of inter-organisational data exchanges. The result showed that perceived information quality is highly predictive of trust and perceived risk, in an inter-organisational data transfer. Other studies that support the impact of information quality on information system success include (Rai, Lang, and Welker, 2002; Papino et al, 2002; Amutairi and Subramanian, 2005; Eom et al, 2012).

- **System Quality**

System quality can have significant impact on trustworthiness. System quality consists of performance measures used by system users to evaluate information system trustworthiness. System quality is identified as a pre-requisite for information system success (Byrd et al, 2006; Petter et al, 2008; Zaied, 2012; Wei, Loong et al, 2009). The more system users perceive good system quality, the more they will trust an information

system and the more successful the system. Elements for measuring system quality include usability, availability, adaptability, reliability, predictability, accuracy, fast response time, ease of use which are valued by system users (Fan, 2006; Rai et al, 2002).

The importance of system quality can be seen in a variety of research. Iivari (2007) tested a model of the D and M IS Success Model using the field of study of mandatory information systems. He found out that perceived system quality was a significant predictor of system usage and that system quality and information quality are significant predictors of user satisfaction with an information system. Zhang et al (2003) carried out a study on the critical factors that affect Enterprise Resource Planning (ERP) in China. The result showed that system quality is a critical factor in the success of ERP in China. Similarly, Lee and Chung (2009) investigated the factors that affect trust and satisfaction with mobile banking in Korea. They found out that system quality and information quality both have positive influence on customer's trust and satisfaction.

- **Service Quality**

Service quality can be positively related to system trustworthiness. Service quality is the measurement of the overall support delivered to system users by an information system and its providers (Fan, 2006). It promotes and tailors strategies for building system users' trust relationship and is one of the key measures of information system success by the D and M IS Success Model (Delone and McLean, 2004). A user's perception of system quality can increase his or her trust in an information system. The more a user perceives good services with an information system, the more he or she will trust the system. Elements for measuring service quality include availability, fast response time, security and privacy (Rababah and Masoud, 2009; Zaied, 2012).

Some studies have investigated service quality using the D and M IS Success Model. Brown and Jayakodi (2008) tested and validated the modified D and M IS Model on 166 online customers in South Africa. They found out that user satisfaction is directly influenced by service quality and perceived usefulness. A study carried out by Kettinger and Lee (1994) on a university computing services department showed that service

quality has a significant impact on user satisfaction. A survey of 18 organisations in a knowledge management context by Halawi et al (2007) showed a significant positive relationship between service quality and user satisfaction. Other studies include Pitt et al (1995) who prove that service quality is a measure of information system effectiveness and Landrum et al (2010), whose study showed that service quality has a significant effect on the success of information systems.

- **Net Benefit, Use and Intention to Use, User Satisfaction and Impact on Trustworthiness**

Net benefit stems from the intention to use, actual use and the satisfaction derived from system use. Net Benefit is the final success variable in the D and M IS Success Model (Delone and McLean 2004). It is defined as the extent to which an information system is contributing to the satisfaction of the different stakeholders (Urbach and Muller, 2012). Net benefit has been investigated and found to be either directly or indirectly linked to system quality, information quality, service quality, system use and user satisfaction (DeLone and McLean, 2003; Petter et al, 2008; April and Pather, 2008; Gorla et al, 2010; Zviran et al, 2005). If net benefit is influenced by information quality, system quality and service quality, then it can be influenced by trustworthiness because quality is an enabler of trustworthiness.

Generally, the empirical studies investigated using the D and M IS Success Model show that the quality of an information system has a significant impact on trustworthiness. It shows that information quality, system quality and service quality enable user perceptions of system trustworthiness.

3.5 Quality versus Trustworthy Attributes of Information Systems

Following the findings from the studies on the D and M IS Success Model (Delone and McLean, 2004), the six dimensions of success contribute towards the understanding of the attributes that enhance users' trust in information systems. In addition, the various

papers reviewed on D and M IS Success Model show that there is a strong relationship between the quality factors in the model and information system trustworthiness. From a user perspective, an information system can be considered trustworthy if it possesses the qualities that a user considers trustworthy (Camp, 2003; Aris et al, 2011; April and Pather, 2008; Hussain et al, 2007). This confirms the findings by Hussain et al (2007) that quality determines the trustworthiness value of a trusted entity. In agreement, Shuang (2013) points out that considerable efforts have been made in designing and developing systems to make them trustworthy by focusing on quality attributes.

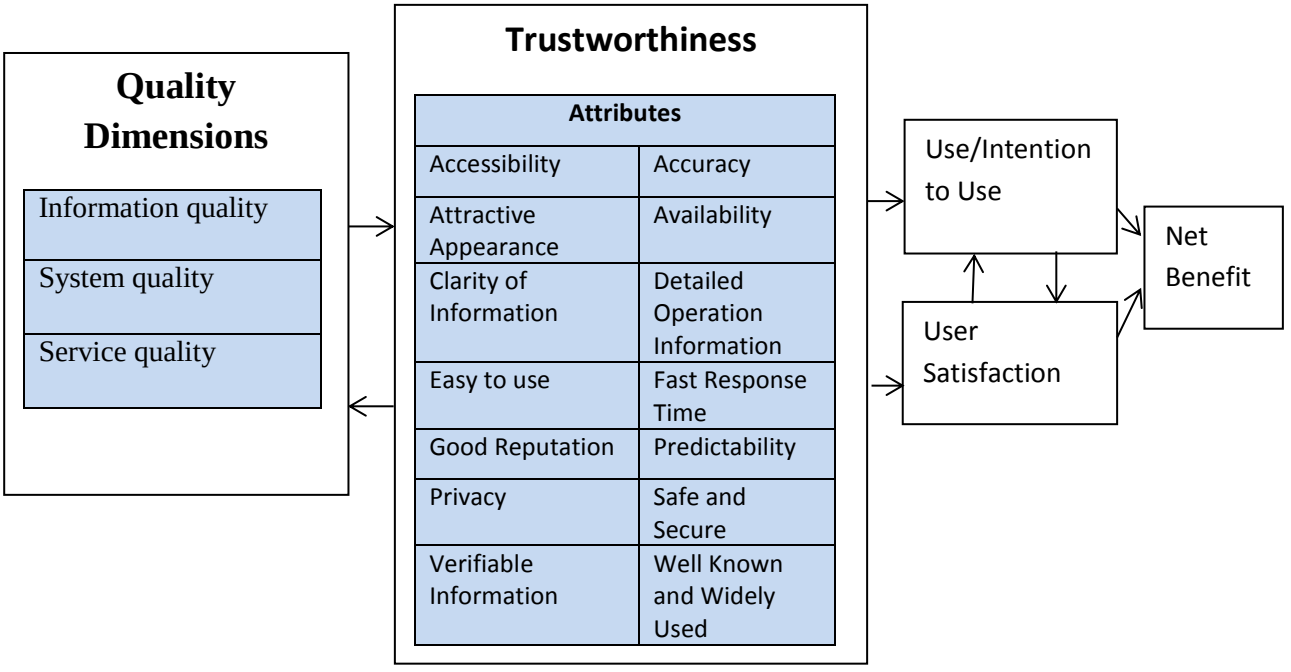
The attributes of trustworthiness used for this purpose are the 14 attributes that were obtained from the empirical studies as shown in Table 3.1. They represent the dependent variables. The independent variables would be different types of information systems in usee.g. a banking information system, an online networking system, a transaction processing system etc. They are variables that can be manipulated to produce predictable outcomes. The dependent variables are the attributes exhibited by each system and can be evaluated by system users to see if they meet their standard for trustworthiness.

To show the relationship between attributes of trustworthiness and quality, we separate the 14 attributes into the 3 dimensions of quality according to their functions as shown in table 3.1. The first dimension is information quality that measures the quality of information produced by a system (Wei et al, 2009). Under information quality are accuracy, clarity of information, detailed operation information and verifiable information. The next dimension is system quality and is defined as performance measures used to evaluate systems' trustworthiness (Zaied, 2012). The dependent variables of system quality are attractive appearance, availability, ease of use and predictability. The last dimension is the service quality that measures the overall support services delivered and information system effectiveness (Fan, 2006; Landrum et al, 2010). The attributes under the last dimension are accessibility, fast response time, privacy, reputation, safe and secure, well known and widely used. The attributes of trustworthy system and their quality dimensions are shown in Table 3.1.

Table 3.1: The attributes of trustworthy information systems and quality dimensions

TRUSTWORTHINESS		
System Quality	**Information Quality**	**Service quality**
Attractive Appearance	Accuracy	Accessibility
Availability	Clarity of Information	Fast Response Time
Easy to use	Detailed Operation Information	Privacy
Predictability	Verifiable information	Safe and Secure
		Well known and widely used
		Reputation

Figure 3.2: The relationship between the D and M IS Success Model and Information System Trustworthiness.



The attributes in Figure 3.2 have been found to have significant impact on use and intention to use, and user satisfaction. Therefore, the attributes of trustworthiness have either direct impact or indirect impact on net benefit that in turn has significant impact on trustworthiness. Figure 3.2 illustrates the relationship.

3.6 Chapter Summary

The objective of this chapter was to investigate the attributes that can enhance user perceptions of the trustworthiness of an information system. This was done by carrying out a review of literature that addresses trust in information systems. This chapter started with discussions on the differences between trustworthiness and trust perceptions because these two terms can be confusing. It discussed the relationship between quality and trustworthiness and described quality as an enabler of trustworthiness based on findings from other researchers. Several models, theories framework and empirical studies were reviewed to capture the various attributes of system trustworthiness because they present ways of understanding behaviours and situations. The trust attributes gathered were defined and analysed to suit the research purpose.

The D and M IS Success Model was used as the theoretical base for this research because of its strong relationship with trustworthiness. The D and M IS Success Model is well known and widely used in Information system research. Its origin and updates were discussed within this chapter. A large number of empirical studies have been influenced by this model and some of these studies were reviewed in this chapter for referral purposes. The last section of this chapter shows the relationship between the quality factors of D and M IS Success model and the attributes of trustworthiness.

The main aim of this thesis was to identify the factors that can affect information system user perceptions of trustworthiness and how this knowledge could be modeled into system design to create systems that are perceived trustworthy. This chapter has identified some trustworthy attributes that can enhance user perceptions of trustworthiness. This will enable this study to tackle the issue of trustworthiness in

system design. The next chapter will discuss this using the 14 attributes of trustworthiness as a guide. It will identify some gaps in the current Information System Development Methodologies (ISDM) with respect to promoting trust perceptions. The focus is on Information System Design Methodologies because they are used to create and build systems (Avison and Fitzgerald, 2006; Iivari et al, 1999). Their trustworthiness during system design can have significant impact on user perceptions of system trustworthiness.

CHAPTER 4

AN OVERVIEW OF INFORMATION SYSTEM DESIGN METHODOLOGIES

4.1 Introduction

This chapter is concerned with a review of the various classes of information system design methodologies (ISDMs) and how they feature trust in their design processes. This will support the research objective of investigating current methodologies and identifying gaps in the current state of art with respect to promoting the trust perception of information systems.

The major aim of ISDMs is to assist in the successful implementation and management of information systems. However, several reasons have been known for the failure of ISDMs to perform as required. Researchers and field workers have acknowledged that information system design development is a complex process, and has a high rate of system failure (Avison and Fitzgerald, 2006). Researchers are therefore concerned with the factors that may lead to system failures and lack of trust in system design. Those factors include delayed projects, projects not meeting expectations, cancelled projects, poor development practices, lack of developmental skills (Boehm, 2002). Many of these failures can occur because of some limitations during system design. This chapter intends to make potential contributions that can help reduce system failures by focusing on the variables that can increase system trustworthiness and trust perceptions in system design. Additionally, it will present some analysis of gaps in each class of methodology that can lead to the potential discovery of new approaches to improve trust features in system design.

This chapter starts by defining the term “Information System Design Methodologies (ISDMs)” and then discusses chronologically, how methodologies have evolved over the years. The phases of evolution of methodologies are in two parts, the pre-methodology era and the methodology era. A brief discussion of the pre-methodology era is given as an

introduction into discussing the methodology era. This chapter gives a review of the different classes of ISDMs, their philosophies, objectives, characteristics, strengths and weaknesses and the inherent features that can either promote or impede trust. The reason behind this discussion to find out how trust is captured during systems design and development process using the attributes of trustworthiness. Known gaps can also be identified in the existing provision. A summary of what is discussed is given thereafter at the end of this chapter.

4.1.1 The Definition of Information System Design Methodologies (ISDM)

There are many definitions of information system design methodology (ISDM) but none of them has been universally accepted. For instance, Yeghini (2009) suggested that ISDM is a guideline that stimulates the intellectual process of information system development. Checkland and Howell (2005) define ISDM as a process for information system building while Al-Aboud (2011) defines ISDM as a standard process followed in an organisation to conduct the steps necessary to analyse, design, implement and maintain the information system of an organisation. Humphrey (1990) defines ISDM as a set of tools, methods, practices and transformations that are used in the process of developing and maintenance of an information system.

The term "method" has been used interchangeably by some researchers with the term "methodology". However, while a methodology is made up of goals, principles, specific methods and tools that are selected based on an underlying rationale or system development philosophy (Wynekoop and Russo, 1995), methods are a particular procedure for accomplishing a task (Avison and Fitzgerald, 2006; Flynn, 1992). Despite the various definitions of ISDMs, the core objectives of all ISDMs remain the same. They are:

- To deliver a quality and effective system on time
- To build a system that is capable of responding to changes in a dynamic business environment.
- Improve productivity that can meet user expectations.

Prior to reviewing some literature on methodologies, it may be inevitable to briefly discuss two major approaches to handling information systems design because this section deals with systems design and development and will involve these two approaches. They are the hard system approaches and the soft approaches to system design.

4.1.2 The Hard and Soft Approaches to System Design

Over the years, there have been two major generalised ways of viewing information systems design. The first is the hard system approach and the second is the soft system approach (Kirk, 1995; Daellenbach, 2002; Checkland and Howell, 2005; Yeghini, 2009). The hard system approach starts with a system definition that reveals a well-defined problem to be solved. It observes social phenomena as stable, with repeatable problems that are predictable. It seeks technical solutions to problem solving, and in addition, shows that there is only one way to problem solve (Yeghini, 2009). On the other hand, the soft system approaches focus more on human or the soft aspects of the system. The soft approach views complex situations where there are different views about the definition of a particular problem. It assumes that phenomena is dynamic, unpredictable, chaotic and unmethodical (Hoffer et al, 2002; Checkland and Howell, 2005).

4.2 An Historical Overview of Information System Design Methodologies

This section reviews Information System Design Methodologies (ISDMs). During the past three decades, Information System Design Methodologies (ISDMs) have been the centre of attention for both field workers and researchers because of their crucial part in shaping the modern economy. This section begins by investigating some of the major ISDMs that have evolved over the years, from the later part of the 20th century when the first universally accepted ISDMs came into existence, until the present date. Because no one method is suitable for all projects, many varieties of ISDMs evolved during this

period, each with its peculiar strengths and weaknesses (Kimble, 2008; Avison and Wood- Harper, 1990). Each methodology is best suited for a particular kind of project based on various considerations such as technical, organisational, skills of the developers, preferred supplier, project type, and team consideration (Kimble, 2008; Camp, 2003; Al-Aboud, 2011).

In this section, the discussion on ISDMs starts from the late 1960s when the first methodology was universally accepted and is known as The Methodology Era. The pre-methodology era is used as an introduction to the methodology era.

4.2.1 The Pre-methodology Era

The pre-methodology era represents the period where information system developments were without the use of any formalised methodology (Philipson, 2004). System development was done in an ad-hoc manner and developers had little or no understanding of organisational or business context in which the system had to be implemented (Jager et al, 2010). User needs were rarely met and development was based on individual approaches. Emphasis was on programming and in making applications run in a restricted amount of memory. The system developers were usually overwhelmed and spent more of their time in correcting and enhancing the systems. Things were out of control and this led to poor management of projects and poor communication between users and the developers (Philipson, 2004). It became a major problem that led to the need for standards and a more disciplined approach to system design and development. This need brought about the beginning of the methodology era of the late 1960s (Avison and Fitzgerald, 2006; Avison and Wood- Harper, 1990).

4.2.2 The Methodology Era

This section gives a brief chronological description of ISDMs. It starts from when the first methodologies were developed until current methodologies.

4.2.2.1 The First Generation Methodology: From the late 1960s to 1970s

The first generation methodologies started from the late 1960s to early 1970s and it included the structured techniques. In the early 1960s, there was a sudden change in market structure and business objectives and the first use of computers where they were employed on a wide scale basis. Systems became large and complex (Boehm, 2006). It became obvious that individual approaches to system development were inadequate for the development of large and complex systems. Most of the programs developed became unreliable and software development went beyond just the writing of programs to include the association of documents and configurable data that were required to make these programs operate correctly (Boehm, 2006; Beynon-Davis and Williams, 2003; Avgerou and Cornford, 1993).

Organisational growth and complexity brought about the need to move away from a one-off solution to problem solving toward a more integrated information system. During this period, more large mission-oriented methodologies emerged. Some were successful, but many more were unsuccessful. Some failed completely, while others required near complete re-work (Boehm, 2006). Projects ran out of budget, and had schedules that led to wastage of time, efforts, stress, financial losses and reputation. There were larger gaps between the needs of the users and the capabilities of realising them. These problems led to the software crises of the early methodology era. As a result, two conferences sponsored by The NATO Science Committee in 1968 and 1969 were held in Germany to try and bring some order and discipline into system development (Avgerou and Cornford, 1993; Boehm, 2006). Many professionals attended the conferences. Among them were service users, stakeholders, manufacturers, researchers, developers, engineers and teachers to discuss all aspects of information system development that included system design, implementation, distribution, services provision, specifications, cost, and difficulties in meeting schedules. The conferences marked a major shift in the perception of information system development (Wirth, 2008). In 1970, after the conferences, The System Development Life Cycle SDLC, a conceptual model that describes the stages that are involved in information system design was proposed. The most common was the

Waterfall Model or the Traditional Approach to information system development. In addition to that, a wide range of other methodologies emerged after the SDLC, offering concrete guidance on how development should be done (Avison and Fitzgerald, 2006; Flynn, 1992). These methodologies later became very popular and influential in the 1970s and the 1980s. They are the structured approaches to information system development.

4.2.2.1.1 The Waterfall Model (The Traditional Approach)

The waterfall model was the original SDLC (Robb, 2004). It is classified as having six steps of strict sequence of the development processes flowing steadily downwards and cannot be violated. The six phases are the feasibility study, system investigation, system analysis, implementation, review, and maintenance.

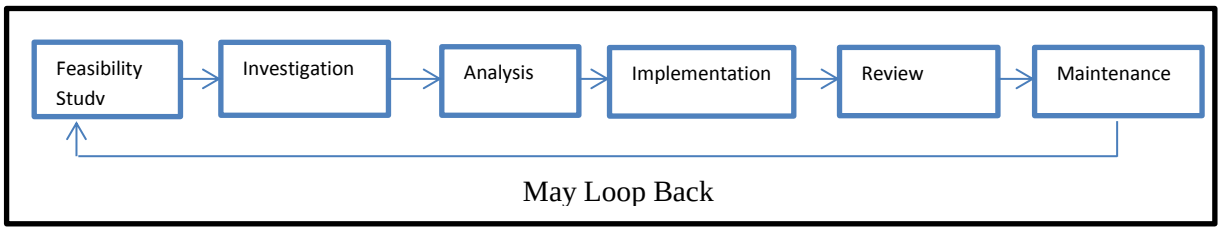


Figure 4.1: The Waterfall Model (Avison and Fitzgerald, 2006). Shown are the six phases of design process that flows from top to bottom like a waterfall.

The success of the traditional approach to information system development, led to many other approaches and methodologies in the early 1970s (Boehm, 2006). This marked the beginning of the methodology era.

4.2.2.2 The second Generation of Methodologies: The early 1980s to early 1990s

In the early 1980's, information system development had a major shift from data and processes of the first generation to focus on constructing and checking of models (Philipson, 2004). Structured methodologies became less widely used because of the limitations associated with them in favour of faster, cheaper and more reliable

methodologies. The wake of this era saw a tremendous increase in productivity, staffing, training, increased tools, software re-use, defect prevention, process improvement and prototyping. Project management was introduced, and so were expert systems and very high-level languages. The use of case-tools, object oriented languages, and rapid applications emerged to take care of the limitations of the structured approaches. Information systems began following a bottom up approach to requirement gathering rather than a top down requirement to capabilities approach (Boehm, 2006). The predominant methodologies were object-oriented methodologies.

4.2.2.3 The Third Generation Methodologies of the 1980s to The 1990s

In the early 1980s, the second-generation methodologies became rather low-level and could no longer fit the changing global market and businesses that must respond to competition and new opportunities. Six-sigma then emerged for measuring operational performances in companies because of the changes, and new techniques and tools also emerged for process improvement (Richardson, 2007). In addition, there was the introduction of Quality Management to control the best features of quality assurance practices. Risk Management was introduced to identify various threats to information system success and to eliminate negative threats (Avison and Fitzgerald, 2006; Boehm, 2006; Philipson, 2004). Users and stakeholders gradually became interested in participating in system design and demanded the fast delivery of systems. The best way to meet these demands was to turn to prototyping in addition to the involvement of users and stakeholders in system design (Iivari et al, 1999). Therefore, user and stakeholder involvement and fast delivery of systems became critical requirements. These were the primary concerns of the third generation methodologies. Two major classes of methodologies became predominant and were known for their focus on timeliness, quality of product and user participation. They were the prototyping and the participatory methodologies (Boehm, 2006; Beynon-Davis and Williams, 2003; Butt and Ahmad, 2012; Philipson, 2004).

4.2.2.4 The Methodologies of the Digital Economy and Best Practices of 2000 and beyond

As the year 2000 was unfolding, the presiding methodologies could not handle the challenges of the changing market and business structure. Organisations tend to either abandon the notion of methodology completely, or develop their own in-house methods for system development (Tumbas and Matkovic, 2006). As a result, Agile methodologies emerged to handle those challenges that other methodologies could not (Abrahamsson et al, 2003; Al-Aboud, 2011). Agile methodologies are development methodologies that speed up information system development dramatically. Every participant in the system design and development process, including the system users, is empowered to collaborate and make team decisions in addition to continuous testing and continuous integration until the required system is achieved (Boehm, 2006; Highsmith, 2002; Wirth, 2008). They are alternative to the traditional methods and this makes them very popular and high in demand (Wirth, 2008).

4.3 Classes of Information System Design Methodologies (ISDMs)

This section presents the available ISDMs. Two decades ago, Jayaratna (1994) estimated the number of ISDMS to be over a thousand and this number is expected to have doubled by now. To handle the proliferation of the ISDMs and provide a better understanding, the ISDMs are grouped under different classes. Each class has basic features and related philosophy. The features and philosophy that they share capture their behaviours (Iivari et al, 1999). After investigating each class of methodology, one of them will be singled out for further investigation. This is because each methodology is merely one instantiation of a more general abstract class.

There are many classes of methodologies identified by various researchers and these classes are classified according to themes and features (Avison and Fitzgerald, 2006). Glisson (2008) classified his study of methodology into two broad classes: The Traditional Driven Approaches and the Agile. Tumbas and Matkovic (2006) classified

their studies into three categories: The Structured Methodologies, The Object Oriented Methodologies and The Agile Methodologies. Dyck and Majchrzak (2012) classified theirs into three categories: The Fundamental Methodologies, The Integrated Methodologies and The Agile Methodologies. Russo (1995) gave a five-group classification: The Structured Approaches, Prototyping/Iterative Approaches, Rapid Application Development, Object Oriented Methodologies and Others while Avison (Avison and Fitzgerald, 2006) came up with seven categories: The Process Oriented Methodologies, The Blended, Object Oriented, Rapid Development, Peoples' Oriented, Organisational Oriented Methodologies and The Frameworks.

This thesis has adopted the methodology classification by Russo, and has slightly modified it to suit modern day changes. This classification was adopted because of the expressive power of the researcher on how each class of methodology progressed into another, and the different characteristics of each class. It shows clearly the strength and weaknesses of each class of methodology. This will enable this study to investigate how trust is featured in every class of methodology. Five classes of methodologies are identified. To analyse the five classes, one methodology from each class is briefly discussed.

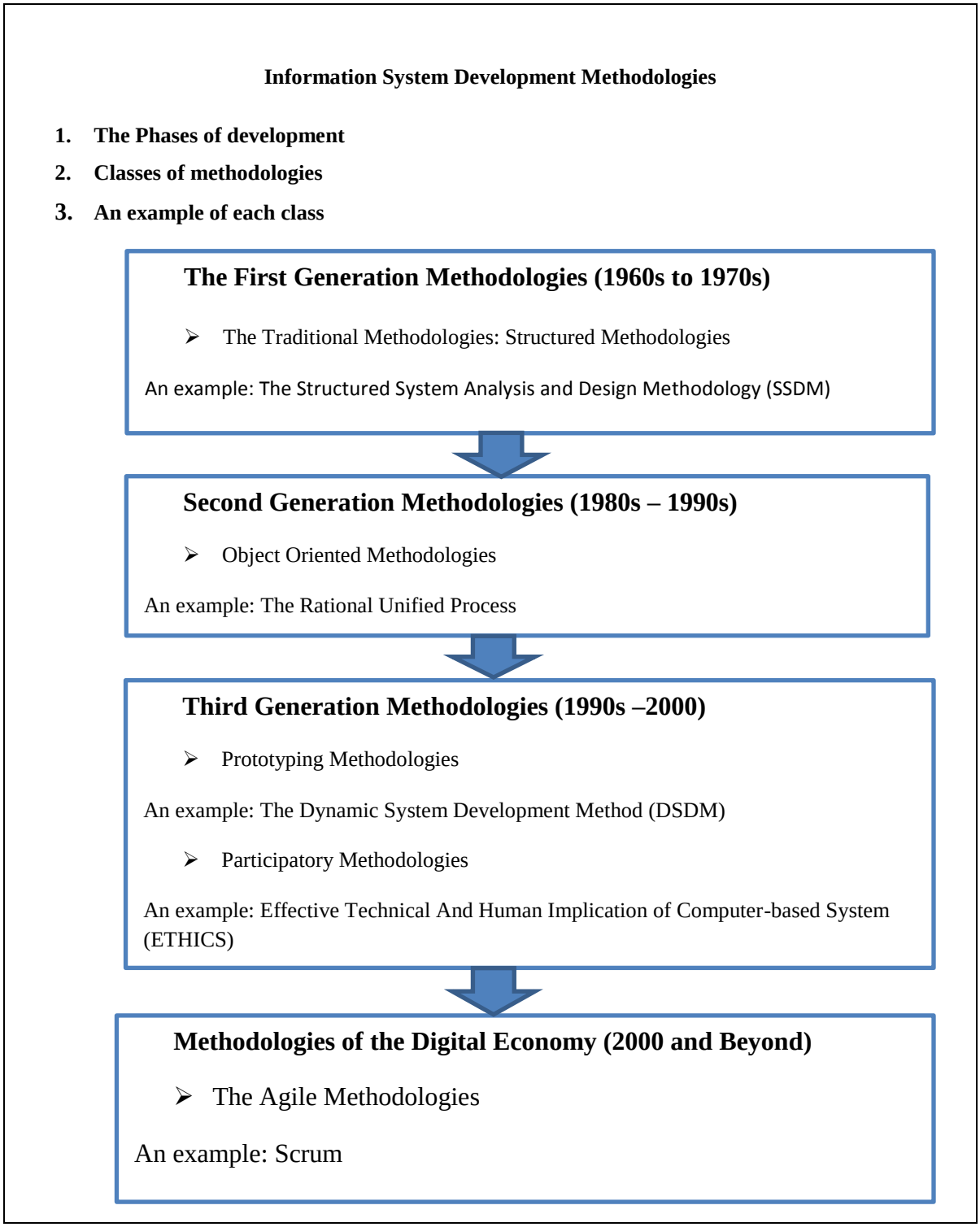


Figure 4.2: The four generations of the methodology era and the five classes of Information System Development Methodologies (ISDM) with an example of each class.

Figure 4.2 shows the chronological development of ISDMs, the different classes, and an example of each class that will be discussed later.

4.3.1 The Structured Methodologies

The Structured System Methodologies emerged in the 1970s and the early 1980s. They followed the concept of the SDLC and the development was either process or data oriented (Al-Aboud, 2011). They are hard systems and make use of rigid techniques and procedures in dealing with each stage of the system development to provide a clear solution to well defined problems (Avgerou and Cornford, 1993). They capture system requirements in policy terms, focus more on the technical factors of information systems, and incorporate the concept of a top-down functional decomposition with clear cut documentation at the end of each phase. The documentation leaves behind traces of developmental work and provides a basis for the maintenance activities needed to support the system throughout its lifetime (Avgerou and Cornford, 1993). They can be applicable to large systems, are plan-driven, and adopt a prescriptive approach to development. The modules, stages and activities to be carried out are specified in advance (Pefkaros, 2008). The principal tools incorporated are the Data Flow Diagrams (DFD), Entity Relationship Diagrams (ERD) and Data Dictionaries. Examples of the methodology are Structured Analysis Design and Implementation of Information Systems (STRADIS) developed in 1970; the De Marco's Structured Analysis developed in 1979 and the Structured Systems Analysis and Design Methods (SSADM) developed in 1981. Additionally, they include MERISE, the Yourdon and Demarco, the Unified Software Development Process, The Jackson Structured Design and Structured Program Design Language (Jackson, 1975; Avison and Fitzgerald, 2006; Jacobson et al, 1999). The Structured Approach includes formal specifications used to help in discovering and understanding the problems in requirements and for implementation of systems (Boehm, 2006; Fitzgerald et al, 2002; Guttang et al, 1982).

By the end of the 1970's, problems began to crop in with the structured approaches. The first outstanding problem was that of intensive documentation. The next was that systems were becoming too slow and costly to the users. Managers were pushing their teams into

coding and spending less time on the requirement and design phases, and projects were running out of budget. In addition to these limitations, some of the methodologies were developed from theories that were mainly based on academic activities, a few of them were occasionally used for system building and as a commercial product (Rico, 2005).

4.3.1.1 The Structured System Analysis and Design (SSADM)

The Structured Systems Analysis and Design Methodology is a highly structured methodology for system design. It was adopted by the United Kingdom Government as the mandatory method to be used for all government projects because it was found to meet the needs of the government's information systems (Hoffer et al, 2002). It is used mainly in information systems where the modules, stages, tasks, deliverables and techniques used are specified before implementation. It covers the systems life circle from the feasibility study to the design stage but does not cover the issues of construction, testing and implementation of software. This methodology is a strategy and consists of tools, various techniques, documentation and different tasks integrated to develop a system (Pefkaros, 2008). The tools in use support the activities throughout the systems development process to increase productivity and improve the quality of the systems (Dixit and Kumar, 2007). It has seven stages which are:

1. The feasibility studies
2. Investigation of the current environment
3. The business systems option
4. Definition of requirements
5. Technical system options
6. Logical design
7. Physical design

4.3.2 The Object Oriented Methodologies

Object Oriented Methodologies are modeling languages that use object oriented approaches for system design (Munassar and Goverdhan, 2011). They function by organising computer programs logically into larger abstractions known as objects to

reflect the real world. This is done to give computer programs fewer modules for easy design, easy programming and easy maintenance (Frank, 1994; Munassar and Goverdhan, 2011). They follow an iterative, incremental approach to system development and consist of several incremental phases: the inception, elaboration, construction and transition phase (Booch et al, 1998). During the incremental processes, all the phases of the development processes are visited repeatedly until the developers are satisfied with the system developed (Frank, 1994).

Object Oriented Methodologies use UML notations which include: use-cases, class diagrams, and sequence diagrams. They can easily be understood by any trained individual and can adapt to the rapidly changing customer needs. As a result, they can increase user satisfaction and improve user reliability on systems (Robb, 2004; Butt and Ahmad, 2012).

4.3.2.1The Rational Unified Process

The Rational Unified Process (RUP) is an example of an object-oriented methodology. It was developed at the Rational Corporation in 1998 (Jacobson et al, 1999). It is a process framework and can be extended to match the specific needs of a system. The RUP has an evolutionary and iteration approach. It is characterised by a large volume of process guidelines and it is often used as a plan driven methodology. The RUP is described as best suited for large projects. It consists four phases (Krutchen, 2004) which are:

1. Inception
2. Elaboration
3. Construction and,
4. Transition

These phases can be further broken down into iterations with each iteration making up nine works known as disciplines. The effort spent on each discipline is dependent upon the phase in which the iteration is taking place. Each discipline defines a set of activities, guidelines and roles including some examples of its modification and the configuration needed by the adopting organisation (Jacobson et al, 1999). Some of its best practices

include the following: the development of systems iteratively, the ability to manage requirements and the application of component-based architecture that allows use-cases to drive the architecture throughout the life cycle. The RUP models systems visually because it uses UML that is a graphical language for visualising, constructing, and documenting the artefacts of a system (Booch et al, 1998). It verifies the systems' quality continuously and controls changes to the system (Kruchen, 2000). Elements can be integrated progressively and this enables potential risks to be discovered during integration. The iteration development provides any organisation and their management with a means of making tactical changes before the final stage of the development. In addition, iteration facilities can be re-used (Fitzgerald et al, 2002; Munassar and Goverdhan, 2011).

4.3.3 The Prototyping Methodologies for Information System Design

The prototype methodologies originated in the 1990s following the changes in the economic conditions of the late 1980s. They came about because of the need to build information systems that were faster, cheaper, and of better quality than the traditional methods (Pefkaros, 2008). Prototyping methodologies are hard system methodologies and have strong links to object oriented languages. The main purpose of prototyping was to satisfy the user quest for accuracy and timeliness. Through user involvement in systems design, the user could specify his or her information needs (Butt and Ahmad, 2012).

The prototyping methodologies follow an iterative and incremental life cycle that consists of continuous testing and refinement. During these processes, projects are broken into smaller units for ease of use. Small-scale models of the system are developed following the iterative modification process until the prototype evolves to meet the requirement of the users without exceeding the deadline (Crinnion, 1991; Bertelson, 2000; Butt and Ahmad, 2012). User involvement throughout the building process increases the likelihood of system acceptance (Crinnion, 1991; Beyer and Holtzblatt, 1998; Butt and Ahmad, 2012). Prototyping approach also signifies the James Martins Approach to rapid development whereby less emphasis is on task planning while more emphasis is placed

on systems development (Martin, 1990). The tools used include Graphic User Interface (GUI), CASE (Computer Aided Software Engineering) tools, Database Management Systems (DBMS), Fourth Generation Programming Languages and, in addition, object oriented techniques. It also includes Joint Application Design (JAD) that is a group based method for the collection of user requirements for the creation of system design (Yeghini, 2009).

The basic steps involved are the identification of basic requirements, development of the initial prototype, review, revising, and enhancing of the prototype. The third and the fourth steps are repeated until suitable for operation.

Researchers have identified three basic types of prototyping (DeSantis et al, 1997; Crinnion, 1991). They are:

1. The Rapid Prototype also called the Throwaway Prototype.
2. The Evolution Prototype: Examples are the Systemscraft, The Evolution Rapid Development (ERD) that was developed in 1997 by the Software Productivity Consortium and The Integration Agents for Information Technology office of the Defence Advanced Research Projects Agency (DARPA).
3. The Incremental Prototype: These include, The Rational Unified Process (RUP), Object Process Methodology (OPM), and Object Modeling Technique. Object Oriented Analysis. Other examples are the Dynamic System Development Method (DSDM), and Extreme Prototyping.

4.3.3.1 The Dynamic System Development Method (DSDM)

The Dynamic System Development Method (DSDM) was first released in 1994 by a group of non-profit system developers in companies with an interest in rapid development (Crinnion, 1991; Fitzgerald et al, 2002). It places high importance on the use of prototypes as a core technique to gather user requirements and to drive development. The DSDM prototypes are intended to be incremental and start from simple forms expanding into forms that are more comprehensive. This method is very useful for

systems that are developed in a short time span and where requirements cannot be frozen at the start of the system building phase. Therefore, the iterative development nature and the active participation of users throughout the system development improves system quality (Abrahamsson, 2003). Moreover, cooperation between all team members and the stakeholders is essential and the teams are always empowered to make decisions (Baird, 2002).

In DSDM, the analysis, the design and the development phases can overlap. This enables phase deliveries by creating a prototype in advance that is eventually signed off by the user. Testing takes place throughout system building and is merged with other phases (Baird, 2002; Beynon-Davis and Williams, 2003). The phases of DSDM are:

- Feasibility and the business study
- Functional model iteration
- Design and build model
- Implementation

4.3.4 Participatory Methodologies: A People Focused Approach

The first and the second generation methodologies were criticised by users (Jason and Dubravka, 2003). They failed to bring the much-needed results to the users and stakeholders because they did not really have an in-depth understanding of user requirements as users were not fully involved in system design (Spinuzzi, 2005). Participatory methodologies emerged as a solution to correct the deficiencies of other methodologies. They are founded on a theory that explicitly resists the notion that knowledge can be classified and completely formalised (Mirel, 1998; Spinuzzi, 2002). This theory favours the change from the usual trend that saw people adapting to technology into technology adapting to people. Therefore, user participation became the key factor in system design (Lapiera et al, 2006).

Participatory methodologies claim meaningful user involvement, reduced worker alienation and increased workplace democratisation. It has a humanistic and social view to information systems. It gives room to direct communication, mutual understanding,

cooperation and reasoned argument between users and developers and is known to liberate and empower all participants. The participatory methodologies include Effective Technical and Human Implementation of Computer-based Systems (ETHICS), Contextual Design (Beyer and Holtzblatt, 1998), The Scandinavian Collective Resource Approach (Kraft and Bansler, 1994), and KADS (Fitzgerald et al, 2002).

4.3.4.1 The Effective Technical and Human Implications of Computer-based Systems (ETHICS)

Mumford developed the Effective Technical and Human Implication of Computer-based Systems in 1995 based on the participative approach to information system development (Mumford, 1995). It integrates the objectives of the organisation in the process of satisfying the needs of the users at the same time. It is of the view that for a system to be effective, technology must fit closely with the social organisational factors (Avison and Fitzgerald, 2006).

ETHICS is derived from organisational behaviour that portrays the development of computer-based systems as fundamentally concerned with the process of change rather than only a technical issue. The second philosophy of ETHICS is that of participation of parties affected by the system (Hutchings, 1996). The participants include the representatives from the user group, development and management teams. The conflicts experienced by all the participants during the change process are exposed, negotiated, and the best solutions that meet the interest of the participants are arrived at. ETHICS consists of 15 stages and they are:

Stage 1: Identifying the need for changes

Stage 2: Identifying the boundary of the system that is to be developed

Stage 3: Description of the existing system

Stage 4: The definition of key objectives

Stage 5: The definition of key tasks

Stage 6: The definition of key information needs

Stage 7: The diagnosis of the efficiency

Stage 8: The diagnosis of the needs and job satisfaction

Stage 9: The future analysis,

Stage 10: Specifying and weighing of efficiency and job satisfaction

Stage 11:Organizational design of the new system

Stage 12: The technical option to determine the technical aspect of the system

Stage 13: Preparing the detailed work design

Stage 14:The implementation

Stage 15: The evaluation

ETHICS has undergone some changes over the years but the most important factor remains, and that is the participation of the stakeholders and users in the system design. ETHICS believes this as the most effective way to achieve a clear and comprehensive knowledge of the users' needs (Mumford, 1995).

4.3.5 The Agile Methodologies

The Agile methodologies emerged to improve user and stakeholder satisfaction in information system development. They are flexible, malleable, soliciting early market feedback about system designs, and bringing improved and completed system designs to the market as rapidly as possible (Philipson, 2004). Because of these objectives, Agile's major representatives from different Agile methods met and decided to form an Agile Alliance to promote their views. What emerged was "The Agile Manifesto" that put forward four major value preferences that were published. The manifesto documented the key values of agile development that are:

1. Individuals and interactions over processes and tools

2. Working software over comprehensive documentation
3. Customer collaboration over contract negotiation
4. Responding to changeover following a plan

Ever since the manifesto, the use of Agile has become increasingly popular and is championed by many prolific designers (Boehm, 2002). Agile is adaptive and not predictive. There are no detailed specifications and documentation is minimal. Agile promotes the usage of co-located, small functional teams that support each other through close collaboration and communication among themselves and the stakeholders in order to facilitate intra-knowledge transfer. These actions reduce development time, and increase the chances for success. The processes of specification, design and implementation are consistently done at the same time. The system is usually developed in a series of increments such that each user evaluates each increment and make a proposal for later increments (Abrahamsson et al, 2003). Interfaces are usually developed for the system user using interacting development system. Another unique nature of agile is that testing is integrated throughout the product's life cycle beginning from the early stages until completion (Highsmith, 2002). It focuses on delivering products timely and frequently, and there is a high level of cooperation among the stakeholders (Kumar et al, 2014). The most efficient and effective way of conveying information between teams is by face-to-face communication. The different types of agile methodologies include Extreme programming, Scrum, The Cristal Family, Adaptive Software Development, and Dynamic System Development Method DSDM (Goodpasture, 2009).

4.3.5.1 The Scrum

Scrum is an agile system development methodology that evolved more recently to address the dynamic business requirements and adapt to changes. It is a general-purpose project management framework and can be applicable to any project with aggressive deadlines, complex requirements and a degree of uniqueness. Schwaber developed Scrum with the hope of dramatically improving productivity in teams that were paralysed by heavier and process-controlled methodologies (Abrahamsson et al, 2003; Boehm, 2006). Scrum has the following characteristics:

- A living backlog of prioritised work to be done
- Completion of a largely fixed set of backlog items that are in a series of short iterations
- A brief daily meeting that discusses the progress made, the upcoming work to be done and obstacles encountered.
- A brief planning section which defines the backlog items for the sprint

Scrum enables the creation of self-organising teams and encourages communication among team members and members of other disciplines involved in the project. One of the key principles of scrum is recognising that fundamental empirical challenges cannot be addressed successfully using traditional methods. Therefore, Scrum adopts an empirical approach to problems whilst accepting that no problem can be fully defined or understood. It focuses on maximising the teams' ability to respond to emerging challenges in an agile manner. Scrum has a scrum master, whose primary interest is to facilitate the removal of impediments before the ability of the team to deliver the sprint goal.

4.3.6 Summary of the Classes of Information System Design Methodologies

The parameters used to summarise the classes of methodology are derived from the works of different authors. They are based on the principles and feature of each class of methodology (Kumar et al, 2014; Adman and Warren, 2000; Avgerou and Cornford, 1993; Boehm, 2002; Abrahamsson et al, 2003; Checkland and Scholes, 1990; Krutchen, 2004; Catherine, 2007; Frank, 1994; Pefkaros, 2008).

Table 4.1 Summary of the classes of methodologies

Parameters	The Classes of Methodologies Viewed				
	Structural Approaches	Object Oriented Approaches	Prototype Approaches	Participatory Approaches	Agile Approaches
System/Project Type	Large-Scaled systems where users' needs are clearly defined at the beginning of development	Large, medium and complex system	Medium to small complex systems	Medium to Small-complex systems	Medium to small-scale
Main Objective	To apply discipline to system development while focusing on the technical aspect	Faster, cheaper and easily maintained system, user involvement	Accelerated delivery of system, better quality system, feedback from users, and user involvement	Satisfaction of stakeholders need through user participation and conflict resolution	Satisfaction of user and stakeholders need through user participation, faster and good quality systems
Requirement Gathering	Through user interviews, workshops and discussions	Through interviews and workshops with users and experts, review of the working materials, use cases, and prototypes	Through interviews and workshops with the users, review the working materials, the feature list, use cases and the list of supplementary requirement.	Through user interviews, workshops, meetings, and discussions	Through discussions, meetings with experts and users, continues review of the working material. Obtained iteratively
Documentation	High	Low	Low	Low	Very Low
Approach used and major model	Process oriented approach and data model	Prototyping and data flow diagrams	Prototyping and object model	Participative, sociotechnical	Incremental, iterative approach, Participative
Fault Detecting	Problematic and difficult, defers testing till end of project	Easy, ongoing throughout the system building	moderate, because of iteration	High level of fault detecting	Moderate, due iteration, changing in requirements and the speed to meet requirements may hide faults

Flexibility	Not flexible, due to output-driven orientation	Supports flexibility, can be extended to match specific needs	Supports flexibility	Supports flexibility	Supports flexibility
Re-usability	Not supported	Supported and easily achievable through inheritance and capsulation.	Highly supported and achievable, iteration facilities can be re-used at any phase	Supported; Low	Highly supported and achievable
Quality	Quality is difficult to achieve because of the structural nature and inflexibility	Achievable, through object-oriented designs, continuous testing.	Highly achievable through continuous testing and re-validating	Uses a variety of technology to achieve high quality of system	Enhances agility, gives attention to technical excellence, and pays attention to best architecture and design.
User Involvement	User involvement is generally very low. Users are involved in the phase of collecting requirement, and during validation of the system	Users are involved at the requirement stage for information gathering. Subsequently, users role are predominantly confirmatory during product review and at every stage.	Users participate in information gathering. User involvement is predominantly confirmatory at checking, validating of artefact, iteration and evaluation.	User involvement is very high and at every stage of the system building	Very high User involvement in all the stages of system building with experts, developers and users working as a team with support and trust for each other
Productivity	Productivity is low because systems are large, highly controlled process and time consuming; High error rate has impact on productivity.	Productivity is moderate. Language requires time because of the complexity in creating programs while interacting with objects.	High Productivity; because of its accelerated delivery system	Low productivity because it is time consuming	Very high because of its agility
Adaptability to Change	Low; changes are hard to achieve	High; part of the system can be updated without affecting other phases.	High; system can be extended to meet specific needs. System can be verified, updated, changes can be controlled continuously	High; system is fundamentally concerned with change process	Very high; easily adapted to changing user needs

Reaction to Different point of view	Different views are collected and documented during requirement gathering	Supports different views as multiple perspectives to same problem are collected and used to resolve problems	Different views are collected, assessed and integrated iteratively	Different views are identified, relevant views gathered and conflict resolved in sociotechnical manner	Different points are welcome, assessed and integrated.
Overall Users satisfaction	Low	Moderate	Moderate to high	Moderate to high	Moderate to high
Planning	High, well-structured and follow due process	Low, create objects from real world situation.	Low, Follow trial and error in system development in the forms of iterations	Moderate, because of the stages involved in the development process	Very Poor, respond to change over following a plan

4.3.7 The Methodologies: Their Strength and weaknesses

Besides the philosophy and characteristics of the classes of the methodologies described earlier in this chapter, the strengths and weaknesses of each type of methodology is described in this section.

- **The Structured Approaches: Strengths and Weaknesses**

Although the structural methodologies were a major step in information system development, there are quite a number of strengths and weaknesses associated with them (Avgerou and Cornford, 1993; Avison and Wood Harper, 1990; Beynon-Davis and Williams, 2003; Boehm, 2006; Hutchings, 1996; Rico, 2005). These are enumerated in Table 4.2.

Table 4.2: Strengths and weaknesses of the structured approaches

S/N	Strengths	Weaknesses
1	The stages of the development cycle enforce discipline such that every phase has a start and an end, therefore, progress can be identified.	Phases are inflexible, cumbersome, and move step by step down slowly. Problems that arise in one phase may propagate to the next phase and can

		cause serious problems in the final output. There is no going back when work is completed on a particular phase. Otherwise, the cost of going back increases and a great number of working hours are invalidated.
2	There is minimum planning upfront for each of the steps to be followed. More time is dedicated for system design	Complete and accurate requirements are never gathered before the completion of the requirement phase due to non-clarification of the users' needs. Often, system users do not really know what they want upfront, rather, their want often emerge out of repeated interactions over the course of any project.
3	The use of documentation helps to ensure that proposals are complete and are properly communicated to organisational staff and users.	Businesses and their environment change frequently. Due to the output driven orientation of the design process, changes in any of the stages are very difficult and costly.
4	The organisational staff and users involved are given training on how to use the system. Flowcharting is used to document computer programs and the analyst and developers are well informed and have standard training.	Despite the training users receive, there is a high level of users' dissatisfaction because of the inability of users to see the system before they are operational. Users are not directly involved with the system development process and therefore cannot change requirements once the requirement phase is completed.
5	The structured nature allows the division of project into phases of manageable tasks. The controls provided assist in the limitation of missed cutover dates and disappointments. It also ensures that one has a better hold on the entire development process.	Can only be used in projects that are relatively stable and where users' needs are clearly identified at the initial stage. It is not possible in complex systems because of the structured nature

- **The Strengths and Weaknesses of the Object Oriented Methodologies**

There are quite a number of strengths and weaknesses associated with the object-oriented methodologies (Booch et al, 1998; Krutchen, 2004; Robb, 2004; Satzinger et al, 2005; Pefkaros, 2008; Frank, 1994). These are described in Table 4.3.

Table 4.3: Strengths and weaknesses of the Object Oriented Methodologies

S/N	Strengths	Weaknesses
1	Reduced Maintenance: One of the strengths of the object-oriented methodology is that the systems in use can last longer and also have a far smaller maintenance cost. Any part of the system can be updated without making large-scale changes because of the modular design.	Not suitable for all types of systems: It is only suited for a dynamic interactive environment and applying object orientation to other types of environment, will not work out well.
2	Real World Modelling: Real world situations are often modelled in a more complex way, and the models are based on objects, rather than processes and data	Object oriented methodology is not technology based. Therefore, the object-oriented language used for problem solving may be challenging and may require time for practicing because of the complexity in the creation of programs based on interacting with objects.
3	Improved Reliability and Flexibility: Can offer multiple perspectives on the same information and this allow the system users to personalise the contents that are of relevance and of interest to them.	No provision for documentation
4	Re-use of previous work: Inheritance and capsulation promote reusability. A new object automatically inherits the data	

	attributes and the characteristics of the class from which it is spawned. Subsequently, the new object inherits the data and the behaviour of the superclass in which it participates	
5	Faster System Development at Lower cost: Re-usability of previous work lowers the cost of development. This enables more focus to be directed to object analysis and design. This lowers the development cost and limits the time spent on system development allowing more time for verification	

The Strengths and weaknesses of the prototyping methodologies:

There are quite a number of strengths and weaknesses associated with the Prototyping Methodologies (Iivari et al, 1999; Avgerou and Cornford, 1993; Bimrah et al, 2007; Crinnion, 1991). These are enumerate in Table 4.4.

Table 4.4: Strengths and weaknesses of Prototyping methodologies

S/N	Strengths	Weaknesses
1	The prototyping approach can be used for complex systems as a development strategy	The approach used may increase complexity as scope of the system may expand beyond the original plan, and incomplete application may lead to application not being used
2	Higher quality system are delivered at a faster rate and relatively low cost of investment	Haste with the delivery of the prototype, may produce shortcuts in the analysis, solutions,

		evaluations, testing and documentation that may lead to application not being as was initially designed.
3	It has a high rate of active user involvement and computerised development tools. Users get to understand the system being developed and are able to give feedback leading to better solution and better quality of system produced	The users involved may have unrealistic expectations
4	Errors can be detected and fixed earlier, and missing functionalities can be identified easily	

- **The Strengths and Weaknesses of the Participatory Approaches**

The strengths and weaknesses associated with the participatory methodologies are enumerated in Table 4.5 (Adman and Warren, 2000; Rico, 2005; Yeghini, 2009; Yourdon, 1993).

Table 4.5: Strengths and weaknesses associated with the participatory method

S/N	**Strengths**	**Weaknesses**
1	Users' contributions are not just confirmatory, but forms an essential part of system design process, where developers hear the concerns of users, and then provide a solution based on that. Involvement include top to bottom participation and includes avenues for group meetings and interactions and regular verifications (Spinuzzi, 2005).	The participatory methodology is incapable of resolving real life situations fully because it is more of human-computer interactions in a socio-technical environment where technological factors prevails (Adman & Warren, 2000).
2	Produce high quality systems that meet users' satisfaction. The computer supported cooperative	It takes a lot of time and there are no deadlines. However, the

	work between the users' stakeholders, and designers' bridges different types of knowledge and all the participants value each of the knowledge contributed. It produces an environment that promotes the ability to capture diverse information. Therefore, the final system produced meets top quality and satisfactory level agreed by all the participants	Participatory methodology involves the systems' direct users and other stakeholders' continuous participation. Some of the participants may fail to show up for future workshops or group meetings and this may compromise the design developed (Spinuzzi, 2005).
3	They promote workplace democracy and rule out dictatorship by managerial control in the work place where workers cannot have a say in their own work and where only trained workers can determine the best way work should be performed. They promote openness and an environment where multiple stakeholders and users with differing disciplines, perspectives and positions come together for a common objective (Bertelson, 2000).	It provides little structure and resources and may not be encouraged for profit oriented businesses (Spinuzzi, 2005).

- **The Strengths and Weaknesses of the Agile Methodologies**

The strengths and weaknesses associated with the agile methodologies are enumerated in Table 4.5 (Baird, 2002; ; Beynon-Davis and Williams, 2003; Highsmith, 2002).

Table 4.6: Strengths and weaknesses associated with the agile methodologies

S/N	Strengths	Weaknesses
1	Promotes collaboration and recommends that the entire team work together, and in a single location where they can maintain frequent and close contact with system users.	Users and teams need to be co-located
2	The Agile Methodologies are better used for small projects	Poor documentation
3	It promotes professional satisfaction and	Users are committed to giving

	motivation and moreover, most technical training can be assimilated as part of the job	regular feedback
4	Developed software can be demonstrated immediately to the users	Time constraint constantly reduces the productivity of experts as they need to train novices
5	People are the primary drivers of systems success and emphases are placed on self-directing development teams.	The reliance on heavy communication through tacit, interpersonal knowledge for success
6	Agile Produce clear and simple system that can easily and rapidly adjust to users' and business changing requirements	Not suitable for large organisations and for large projects
7	The agile methodologies encourage high level of users' participation that involve face to face communication between developers and users and team tacit knowledge is acquired through social interaction.	The absence of explicit documentation may lead to a number of problems such as omissions.

4.4 Modeling Trust in the System Design Process

In this section, the issues of trust in information systems design processes are discussed with extracts from the philosophy, features, strengths and weaknesses of each methodology. The focus is on how trust is modeled by the different classes of methodologies to reflect trustworthiness in information system design methodologies (ISDM). Trust is based on the 14 attributes of trustworthiness from the users' perspective as discussed in Chapter 3. It is not pertinent to examine every single methodology of system design, as there are over a thousand of them according to Jayaratna, 1994 and new ones yet unknown keep springing up. The methodologies that belong to a particular class

are often similar in many ways and as such, discussing them as a group is considered more appropriate.

4.4.1 Discussions on the ISDMs and the issues of trust

This section briefly highlights how the different methodologies tackle the issues of trust based on the 14 attributes of trust provided in the previous chapter.

Table 4.7:Information System Development Methodologies (ISDM) and the issues of trust

Trust Factors During Design Processes	**Classes of Methodologies**				
Trust Attributes	Structural Methodologies	Object Oriented Methodologies	Prototype Methodologies	Participatory Methodologies	Agile Methodologies
Accessibility	Low accessibility, users can only access the system at the requirement stage, and on completion	Moderate access: Users can't access the building process because of the language complexity. They can give feed-back at every stage of development	Moderate to High Access. Users can observe the prototypes, but cannot build them. They can give feedbacks at every stage of development.	High Access: Users' may not have the technical knowledge and may not fully access the technical aspect, but can fully access the social aspect of system design.	Highly accessible due to high level of users' involvement throughout the system design and frequent meetings.
Accuracy	Low level of accuracy, no correction of error after leaving a particular phase, testing	Moderate because they are accurate in dynamic interactive environment	Moderate, level of Accuracy, errors can be detected and corrected through	High level of accuracy, errors are detected using technology	Moderate: resolves obstacles during daily meetings and continuous iteration, errors

	deferred until end of project.	only where errors can easily be detected and corrected during verification	prototypes. Finished product may differ from prototypes		occur because of concentration on speed and less documentation.
Attractive Appearance	Not indicated in the design process, users can not see the system until fully operational	Shown to users through object oriented designs.	Embedded in the designing of the prototypes	Users' participation can have effect on the design and physical appearance of the final product	Users involvement throughout system design and can have positive impact on appearance of the final product
Availability	Availability is very low. System only available to users on completion	Moderate: availability, not suitable for all types of systems. Only available for to users for verification only.	High: System is available as prototypes to users. Users can give feedback at each stage of the development process	High level of availability through users participation throughout the development process	High level of system availability to users at each stage of development and by face to face contact
Clarity of Information	Low: Complete and accurate requirements are not always gathered. Misunderstanding between developers and usersdue to non-clarification of users' needs.	Low: models are too complex for users to understanding. Make use of object oriented language. Users need to be trained for use	High due to users involvement in the development process and prototyping	Moderate. Complexity due the technical nature, participants must be trained before getting involved	High due to facilitating interactions, understanding and trust between participants.
Detailed	High, due to high	Moderate:	Low level of	Low, level of	Low level of

Operation Information	level of documentation	documentation, Programs are created based on interacting with objects	documentation, Concentrates on trial and error with prototypes	documentation. Technology based. Discussions done internally in workshops between participants.	documentation. Plans communicated through face-to face meetings.
Easy to Use	Low due to low level of user involvement	Moderate, the models appear complicated to users	High, because of flexibility of the development process	Moderate: users may find it a bit difficult to use because of the technical aspect.	High, because of flexibility and high level of user participation
Fast Response Time (Timeliness)	Slow and Cumbersome and time consuming	Moderate: require time to practice, it therefore encourage reuse of previous work	Moderate , because of continuous iteration to meet users' requirement	Slow, no deadlines, project may take a lot of time because of difficulty in reconciling human factors and technical requirements	Fast, stick to deadlines.
Good Reputation	High and was widely used for some key projects. Now obsolete. Some are known to be developed based on theories used for academia	Low, and sparsely used, obsolete, not applicable in some environments	Moderate, used in some key projects	Moderate: used in some key projects, known to be slow. usage, gradually declining	Good reputation and high in demand. Ability to handle the changing business requirements, and fastness
Predictability	Low, user needs are defined at the requirement phase, users are	Moderate, through evolutionary and iterative	High: users can predict the final product by viewing the	High: User participation is high, therefore follow through	High because users are involved throughout the

	kept in suspense until the finished product.	approach, can be extended to meet specific need	prototypes	each step and can predict the outcome.	system design, and during continuous iteration, therefore can predict the outcome.
Privacy	Low: Activities in the development phase do not include security. Privacy achieved through privacy laws and regulations	Low: Not indicated in the system design. Privacy obtained through privacy laws and regulations.	Moderate: Approaches to systems' design may include legal and regulatory methods and certifications and organisational control	Low: Difficult to achieve in settings that have fixed technology and less social factors.	Moderate. Through organisational control, social and ethical control, privacy laws and regulation.
Safe and Secure	High: Each methodology has a security checklist and risk analysis. Secured by mapping problems to solutions.	High: methodology has its logical control designs. Highly abstracted designs are used to express problems and solutions.	Moderate. Application of CRAMM, BDSS, Control points, exposure analysis matrix, checklist. Problems and solutions are abstracted by modelling attributes of problems.	Moderate: Organisational control and security laws are used. Techno-centric security applications may be integrated into system development. May lack compatibility with some systems	Low: Few explicit security features because of severe constrains. Few of the security measures integrate poorly into the approaches used.
Verifiable Information	High: Information can be verified	Moderate: through objects that represent	Moderate: through user involvement and	Moderate: Users can verify information	High: There is face-to-face contact and

	through documentation	the real world, and feedbacks	feedbacks	through user participation	daily meetings and collaboration between team members.
Well known and Widely used	Low: obsolete, not used for complex systems. Acceptance level is very low	Low: used in certain environment: obsolete. Acceptance level very low	Moderate: Still in demand for certain projects. Acceptance level is moderate	Low: gradually fading because the contents are not reshaped to meet the changing requirements	High in demand and widely used because of its agility.

Table 4.5 Summary of the investigations into how trust is modelled during system design and development processes using the 14 attributes of trustworthiness.

4.4.2 The Challenges with ISDM Adoption by Organisations

Over the years, ISDMs continue to change rapidly and significantly due to the high level of competitive market structure. Although organisations are adopting the agile methodologies over the other methodologies because of their advantages, there are still some challenges pertaining to the handling of security, privacy and other major trustworthy issues. Agile, despite its advantages over other methodologies, may not be the best solution to the existing problems in information system development, especially for large projects. This does not mean that the use of ISDMs by organisations have not been successful. It means that they have not solved all the problems that organisations and system users expect them to solve due to the various disadvantages of each class of methodology (Bimrah et al, 2007; Iivari et al, 2001).

Whilst still accepting the notion of ISDMs, some organisations adopt the best practices of several methodologies that will satisfy the social requirements of every individual concerned, and provide trust features needed for system development. Some use

methodologies together with a diverse range of non-methodological approach to meet requirements. Some organisations that have not found their appropriate methodologies develop their in-house methodologies and this has led to the rejection of methodologies within such organisations (Papatsoutsos, 2001). The in-house methodology development involves a process whereby an organisation uses own workers to develop and implement information systems. The advantages derived are that organisations can have full control over their system development processes and functionalities and the ability to build systems to meet specific needs. The disadvantages include, high cost of switching from known methodologies, delays, as more time is needed for this process. More skilled and experienced personnel may be required that in turn may lead to high overhead cost, high development and maintenance cost. Most importantly, the possibility of system failure cannot be ruled out because such methodologies may not have proven existing solutions and may have problems with implementing industries best practices (Kappelman et al, 2006; Boehm, 2006: King and Lyytinen, 2006; Benslimane and Yang, 2011).

The knowledge and use of methodologies over the past few decades have helped to improve information system design and development processes when successfully applied (Avison and Fitzgerald, 2006; King and Lyytinen, 2006). However, this chapter explained the existing gaps in the design and development process of information systems that can inhibit users trust. A further step is needed to find out the key trust attributes that can enhance trust during information system design process.

4.5 Chapter Summary

This chapter discussed a hierarchical classification of ISDMs that showed their principles, and essential features. Its major aim was to show how ISDMs feature trust in their development processes. This was intended to bring out the gaps in each ISDM so as to provide an idea for the design of trustworthy systems.

Many definitions of ISDM were considered in this chapter. Despite those definitions, it was acknowledged that there is no universally concise definition of ISDM. The common

ideas between all the definitions are that ISDM consists of goals and tools selected on the bases of an underlying principle. Each is aimed at delivering a quality system that is capable of responding to changes, and improving timely productivity.

This chapter identified some major ISDMs that have evolved over the years. The evolution of the ISDMs, was gradual and in four stages. The first generation was the structural methodologies. The methodologies broke down complex problems into smaller components with well-defined interrelationships between components. It focused on data and processes. The second-generation methodologies were the object-oriented methodologies. Here, development shifted from data and processes to constructing and checking models. These later became obsolete and the third generation methodologies took over. During this period, users wanted faster systems development. Additionally, they became interested in participating in systems' design. Therefore, the participatory and the prototyping methodologies emerged. The next decade ushered in the methodologies of the digital economy and best practices known as the agile. Agile could handle complex systems and the challenges of the changing market than the previous methodologies.

From the first generation of methodologies to this present day practices, five classes of methodologies were identified and each class contain essential features inherited by all the ISDMs in that class. Each class of methodology was investigated based on their philosophy, features, strengths, weaknesses and how they featured trust. A representative of each class of ISDM was further discussed. Structured System Analysis and Design Methodology (SSADM) represented the structured methodologies of the first generation, while The Unified Process (RUP) represented the object-oriented methodologies of the second-generation. The third generation was represented by two methodologies: The Dynamic System Development Methodology (DSDM) from the prototyping methodologies and the Effective Technical and Human Implication of Computer-based System (ETHICS) from the participatory methodologies because these two classes of methodologies emerged in the same decade. Scrum represented the agile methodologies of the year 2000 until this present date.

This chapter investigated how each class of methodology featured trust in their design processes. Gaps were identified. The investigations carried out showed that the structured methodologies were more secured than other methodologies. However, users do not have direct access to them until the development processes are complete. They lack user participation, are unpredictable, slow and have low level of accuracy. The object-oriented methodologies were found to be an improvement on the structured methodologies. However, they lack user participation due to language complexity, difficult to use, slow and unpredictable. User accessibility was for verification purposes. Therefore, they were replaced by the prototyping methodologies.

The prototyping methodologies were discussed to be faster than the previous methodologies. Users were more involved in system design but their role was confirmatory because they could not build prototypes. Users could predict the final systems but sometimes, things went wrong with the finished systems. The systems became less secured and privacy settings were limited to organisational control. Documentation was eliminated. Though they were faster than the previous methodologies, constant verification and testing slowed down their development processes and so, the participatory methodologies took over.

The Participatory methodologies showed high level of user involvement during system design. They were known to be predictable because of the socio-technical nature of the systems. However, they were slow and users found them difficult to use because they were too technical. This gave way to the agile methodologies. The agile methodologies are designed to address the dynamic business requirements and are adaptive to changes. Design processes are very fast because they focus on short-term goal and incremental delivery. Users participate throughout the development processes. Although organisations have high demands for agile, security and privacy issues are not addressed properly.

The review of methodology developments from the structured approaches to the agile approaches showed that each methodology has its limitations, coverage, interest and specific ways of featuring trustworthiness. The move from structured approaches to agile has resulted in faster systems development with user involvement in system design but

has resulted in less secure systems with very low privacy settings. As a result, organisations find it difficult to adopt a particular methodology because trust is not as highly featured in the development processes, as it should be. Therefore, organisations integrate the best practices of different methodologies that may cover the complete span of the development circle with their own trust mechanisms for system design.

A user's trustworthy perception can be an important factor in trusting an information system. Moreover, it can affect the acceptance and continuous use of an information system. Consequently, modelling trust in the system design process of an information system is needed to enhance user perceived trustworthiness. It will be increasingly difficult to model 14 attributes of trustworthiness into a single system design process knowing that there are diverse information systems and all perform different functions in accordance with their aims. Additionally, users view trustworthiness differently and may prefer some trustworthy attributes to others. Therefore, the different views of system users are needed to identify the most important attributes or the key attributes of trustworthiness, from the 14 attributes that can enhance user perceptions of trustworthiness and that can be used in modeling trust in the system design process. This issue is addressed in the next chapter through an information system survey and statistical testing.

CHAPTER 5

INFORMATION SYSTEM SURVEY

5.1 Introduction

In this chapter, an information system survey and statistical analysis were carried out in order to find out the key trustworthy attributes that can be used to model trust in the system design process of an information system. This was done to answer the research question of identifying the key attributes that could enhance user perceptions of information system trustworthiness.

The literature review in Chapter 3 revealed fourteen attributes that can enhance user perceptions of information system trustworthiness. They portray the attributes that users find significant when forming trust relationships with systems. However, it may not be necessary to consider all the identified attributes of trustworthiness before a system is perceived trustworthy because users perceive trustworthiness differently. For instance, a user's choice of trustworthy attribute in a system may be different from another user's choice in a similar system and the same applies to every other user.

Secondly, various systems perform distinctive functions according to their core objectives e.g. accounting systems, training systems and banking systems. Therefore, adopting all the fourteen attributes may not be necessary in determining a particular system's trustworthy attribute. Some key attributes in combination with a system's core function may increase user perceptions of that system's trustworthiness. The problem is therefore that of determining the most important attributes that can increase user perceptions of information system trustworthiness. It was therefore necessary to carry out an information system survey and some statistical testing to determine the key attributes of trustworthiness. Prior to the research survey, a preliminary study was conducted to provide the knowledge and understanding needed for the research survey. The findings are also discussed in this chapter.

5.1.1 A Brief Report on the Preliminary Study

A preliminary study of a survey is a trial study carried out before a survey design is finalised. It is one of the essential stages of a survey and is normally small in comparison to the main survey. It may provide some essential information needed to improve the quality and efficiency of a research (Burgess, 2001).

The objective of the preliminary study carried out was to gain further knowledge and understanding of user perspectives of system trustworthiness. A qualitative interview method was employed because the interviewer wanted a one on one interview with each respondent. The interview was conducted through telephone conversation and face to face contact. This was favourable because of accessibility to subjects and the time constraints for the feasibility study. The sample size was 35. Out of this number, 30 participated fully in the survey and 5 subjects were not available for the interview. The respondents consisted of friends and colleagues.

Each participant in the preliminary survey was given the 14 attributes of trustworthiness and was asked the following questions:

1. Are you a frequent user of information systems?
2. From the list of the 14 attributes of trustworthiness, select one attribute of trustworthiness that you fancy most in an information system?

The result of the preliminary study is shown in Appendix B. Safe and secure had the highest percentage of responses, privacy came second while fast response time came third. The attributes that occupied the fourth position were predictability, attractive appearance, accuracy, well-known and widely used and easy-to-use. The fifth position was occupied by: accessibility and availability. The attributes that did not receive any response were verifiable information, good reputation, detailed operating information and clarity of information.

The researcher benefited from the preliminary studies in a number of ways. Firstly, the preliminary studies assisted the researcher in deciding the survey method to use for the research project. It revealed deficiencies in the design of the proposed survey questions that were addressed before expending it on the research project. The preliminary study also led the researcher to modify the survey question to make it fit for purpose and increase the efficiency of the research. The final result from the research survey may differ from the that of the preliminary study, nevertheless, it has provided a background for the research project.

5.2 Research Method, Data Collection and Analysis

Many methods can be used in collecting data and information necessary for research purposes. Each method used is fundamentally important and contributes to achieving research outcomes. Any research method employed by a researcher can be influenced by several factors such as the research topic, the research purpose, the research questions and the audience (Burgess, 2001; Saunders et al, 2009). The different methods include:

- Experiment: This is conducted under controlled condition to demonstrate a known truth or validate a hypothesis (Bryman and Bell, 2015).
- A Survey Method: That examines or assesses something using questionnaires or statistical survey to gather data or information about people, their thoughts and behaviours (Burgess, 2001).
- Case Study: Involves a process or record of research into the development of a particular person, group or circumstance over a sustained period (Eisenhardt, 1989).
- Action Research: A reflective process of progressive problem solving by teams to improve the way processes are performed and services are delivered (Saunders et al, 2009).
- Archival Research: Is a type of research that involves extracting evidence from original archival records (Donahue and Moon, 2007).

The research strategy adopted in this study was the survey method because of the research aims and objectives, and the audience needed to carry out the study. A non-probability based approach was used for the survey. A non-probability based survey occurs when a researcher can use subjective methods such as convenience, personal experience, expert judgement and purposeful selection to select the elements in his or her sample. A probability-based survey is when a researcher makes his or her choice using probability-based methods that may involve using some procedures that involve list of random numbers or the equivalent (Burgess, 2001).

A sample of individuals, who were all information system users, voluntarily participated in the survey. The participants were able to provide the required information because of their experiences with information systems, and this allowed the researcher to complete a large number of interviews quickly and with limited cost.

5.3 The Information System Survey

An information system survey is a non-descriptive research method used to collect data on phenomenon that cannot be assessed directly (Burgess, 2001). In most research, surveys are used to assess thoughts, opinions and feelings of participants (Burgess, 2001). In the present study, an information system survey was employed to obtain data on user thoughts, opinions, and feelings towards information system trustworthiness.

5.3.1 The Variables used for the Information System Survey

The variables for the information system survey used in this chapter are:

(a) The fourteen attributes of trustworthiness
(b) The subjects or population and their responses

The fourteen attributes of trustworthiness obtained from previous investigations in this thesis were used for the information system survey. These came from models and frameworks form the literature reviewed. The researcher chose this method because models are representations of key concepts. The variables obtained from models were used to give abstract descriptions of quality systems. Additionally, the quality

frameworks that were obtained for the purpose of this study were structures used to underline quality systems or concepts. Each of the attributes that was investigated provided supporting structure and guidance for the quality systems they were attached to. They were products of other surveys and empirical studies that have been assessed and accepted for journals and conference papers.

Whilst going through the literature, there was a strong acknowledgement of the robust relationship between quality and trustworthiness by researchers. Quality was seen as an enabler of trustworthiness (Lee and Nass, 2010; Lee and See, 2004). Therefore, an information system can be perceived as trustworthy if it possesses the desired quality attributes(Camp, 2003; Hussain et al, 2007; Aris et al, 2011).

This study, having captured this essence of the underlying relationship of information system quality and trustworthiness, used the quality factors to represent the system view of attributes of trustworthiness. These attributes were elements used for the information system survey (Table 5.1).

The sample population used for the survey consisted of university members consisting of university students, academic staff and administrators that use information systems regularly from three university campuses. After the survey, the responses were gathered and statistically analysed

Table 5:1: Description of the variables used for the information system survey

	Variables for Information System Survey	
1	Elements	The attributes of trustworthiness
2	Target Population	University members consisting of students, academic staff and administrators
3	Sampling Unit	3 university campuses

5.3.2 The Objective and the Rationale for the Information System Survey

The objective of the survey was to investigate the key attributes that could influence user perceptions of trustworthiness of computer based information systems. It was in response to answering the research question: "what are the key attributes of information systems that can enhance user perceptions of system trustworthiness?"

The fourteen attributes of trustworthiness obtained from empirical studies were used for the information system survey. During the course of investigating some quality factors for systems trustworthiness, it was observed that various studies that dealt with system quality concentrated on the systems of their choice. Therefore, the quality attributes they investigated were applied to such systems. Additionally, each of the systems under study performed distinctive functions according to their core objectives and therefore produced different quality factors applicable to their functions. A collection of all the quality factors from each system gave the fourteen attributes of trustworthiness after performing a word analysis and eliminating repetitive words. Adopting all the attributes may not be necessary in determining a particular system's trustworthiness because they may not fit into a single system design and development process. Based on this, an information system survey was needed to find out the key attributes that could be applied to any information system and that can have significant impact on user perceptions of trustworthiness.

5.3.3 The Survey Design and Methodology

The survey method used for this reseach was Survey Monkey. Survey Monkey is one of the world's leading providers of web-based survey solutions, and their products can be used as simple decision-making devices (Waclawski, 2012). It provides both free and paid programs. This method was employed for this research because of the following advantages: the respondents can control the survey pace that makes it easier and convenient to respond; they can complete and submit it electronically. There is no cost to administer the free version therefore reducing the cost of the survey. The feedback from every respondent is instant, and a large number of people can be reached in a short period.

The limitation for using the free version is the inability to access potentially richer sets of data that the paid programs possess such as sample selection, bias elimination, and data representation tools. Additionally, the result from the survey can be skewed due to potential for error if the respondents misread the questions.

Responses from the survey were gathered and statistically analysed using some non-parametric tests and multiple comparison procedures. The results from the statistical analysis presented the key attributes of systems trustworthiness from a user perspective. This fulfills the research objective of finding out the key attributes that can enhance user perceptions of information system trustworthiness.

5.3.3.1 The Questionnaire and the Cover Letter

The questionnaire used in this study was designed to ensure that the resulting data was not biased. Prior to the interview, the subjects were emailed a cover letter. It included a consent form to fill before taking part in the survey, an information page introducing the subject matter and approval letter from the Research Ethics Committee. These were attached to the email and the general question was asked. The subjects were not compelled to take part in the survey and were free to withdraw from participation at any time without giving a reason for doing so.

The ranking of 6 attributes instead of all the 14 attributes of trustworthiness was to make the survey fast and easy for respondents. If users were asked to rank all the 14 attributes, things could become complicated and time consuming. This may negatively effect the level of response from the entire survey. Ranking was preferred by the researcher because it gives insight into what matters to respondents. Additionally, ranking is very useful if a researcher is prioritizing issues as in the case of this research where key attributes are desirable. The research question asked the subjects to select the six most important qualities from the fourteen qualities of trustworthy information system listed and then rank them in order of importance. Rank 6 was assigned as the most important rank, followed by rank 5, and so on, and Rank 1 was the least important rank. For details, see Table 5.2 and Appendix B1, B2 and B3.

During the survey, the respondents were informed that they could add more attributes that they would prefer to use together with the 14 attributes of trustworthiness that were provided for the survey. This was to prevent bias in the number and type of attributes used for the survey. At the end of the survey, none of the respondents added any attribute to the 14 attributes that were previously provided. This implied that the respondents were satisfied with the 14 attributes provided for the survey (The information sheet, the questionnaire and the survey results are shown in Appendix B1, B2 and B3).

5.3.4 Data Collection

The survey was completed and data collected for analysis. A total of 866 subjects took part in the survey. Out of this number, about 1% of the subjects declined from participating in the survey and 344 (37%) did not complete the survey. The incomplete responses included the 1% of the subjects that clicked on the email and did nothing else but left the page while the 37% included the subjects that neither signed the consent form nor clicked finish after participating in the research. The subjects were not compelled to participate in the research. Those with incomplete responses were excluded from further analyses. 522 (61.9%) of the respondents completed their survey and the responses were used for statistical analysis.

5.3.5 Survey results and analysis

Table 5.2 presents the frequency distribution of the ranking of the 14 attributes as ranked by the respondents. Also included in the table is the percentage distribution for each attribute. The percentage distribution was computed without assigning weights to any of the ranking. Overall, safe and secured received the highest percentage of ranking (12.85%) followed by privacy (9.96%) while detailed operation information got the lowest (4.21%).

Table 5.2: Frequency distribution of the responses for all the 14 attributes

No.	Trustworthiness	Ranking from 1-6						Responses	
	Qualities	**1**	**2**	**3**	**4**	**5**	**6**	**Count**	**%**
1	Predictability	40	26	36	44	28	42	216	6.90
2	Accessibility	35	42	35	52	63	26	253	8.08
3	Safe and secured	11	19	29	36	106	200	401	12.84
4	Fast response time	34	36	51	61	41	16	239	7.63
5	Attractive appearance	92	33	23	10	11	2	171	5.46
6	Verifiable information	40	38	49	36	24	7	194	6.19
7	Availability	33	42	48	40	26	21	210	6.70
8	Detailed operation information	28	47	28	18	6	5	132	4.21
9	Good reputation	45	49	40	33	27	14	208	6.64
10	Accuracy	17	49	50	58	38	34	246	7.85
11	Well-known and widely used	35	36	28	24	16	19	158	5.04
12	Easy to use	49	48	48	39	33	23	240	7.66
13	Clarity of Information	29	36	26	29	19	13	152	4.85
14	Privacy	34	21	31	42	84	100	312	9.96
	Response total	522	522	522	522	522	522	3132	100%

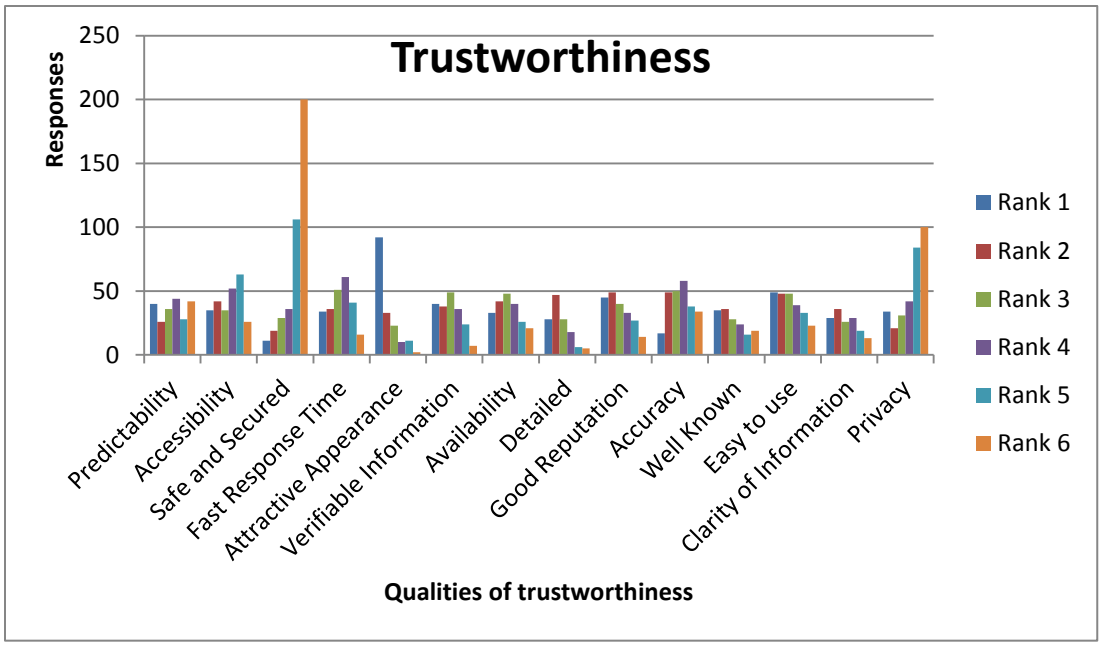


Figure 5.1: The Summary of the responses for the survey across the 6 ranks

The column charts in Figure 5.1 shows the results of the survey on information system trustworthiness. The horizontal axis represents the qualities of an information system's trustworthiness, while the vertical axis represents the number of responses from the subjects that participated in the survey. There are 14 qualities from which each subject chose 6 qualities and ranked them in the order of importance (from 1-6) and rank 6 was the most important quality.

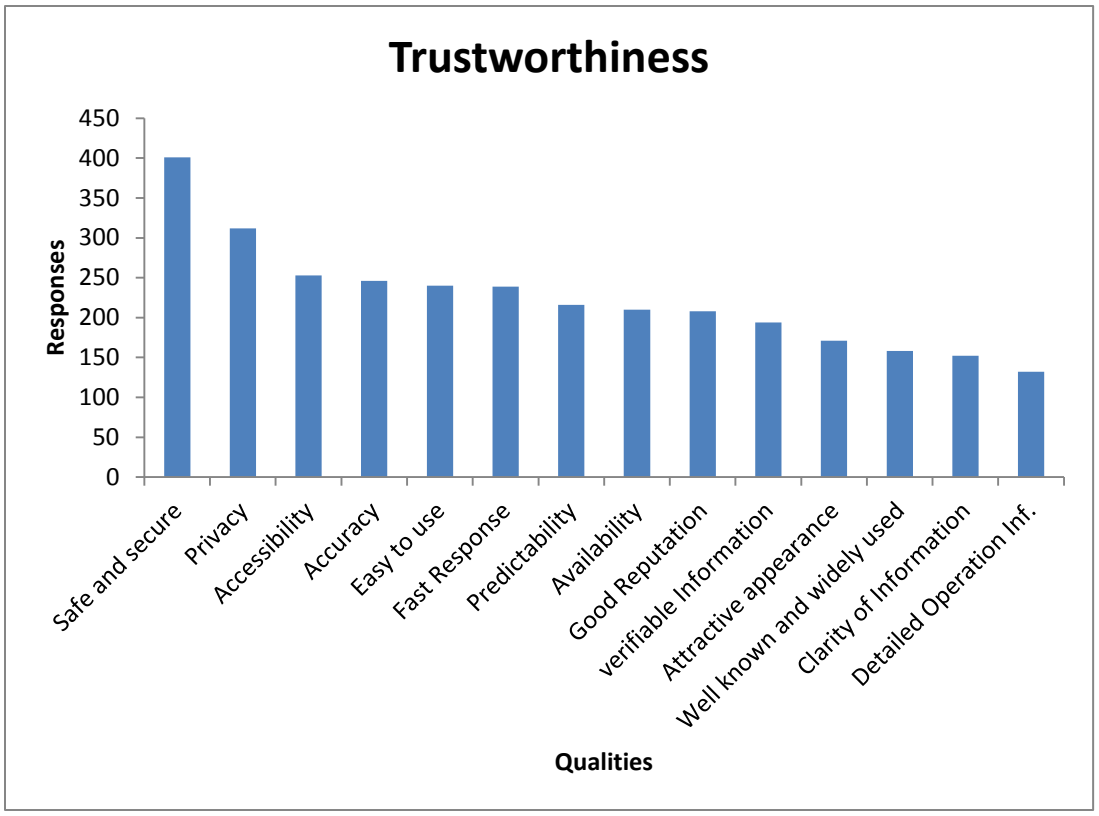


Figure 5.2: A bar chart showing the responsesto the qualities of information system trustworthiness

The total responses value for all the responses across all the ranks for the 14 attributes in a descending order are displayed in Figure 5.2. Safe and secure tops the chart with a total response of 402, followed by privacy with a response rate of 312, and accessibility came next with 253 responses. Accuracy had 246 while easy to use had 240. Fast response time came up with 239 and predictability came next with a total value of 216. Availability came next with a response rate of 210, while good reputation had 208. Verifiable information was next with 194 and attractive appearance had 172 responses. Well-known and widely used came up with 158 while clarity of information had 152 responses leaving the detailed operation with the least value of 132.

5.3.6 Statistical Analysis

Statistical Analysis involves collecting, scrutinising, manipulating and interpreting quantitative data to discover its underlying causes, relationships, patterns and trends. This is to enable the drawing of inferences from the data analysed.

5.3.6.1 The objectives of the statistical analysis and hypothesis

The objective of the statistical analysis was to identify the trend, find relationships and the pattern of distribution of the survey result, and to use these findings to determine the key attributes of trustworthiness from the user perspective.

Whilst analysing the data, the first statistical test was to find out if the data from the responses from the survey were identically distributed. If each variable had the same probability distribution as the others, and if they were mutually distributed. That is, to check that the occurrence of one attribute in the survey did not affect the probability of another attribute being selected. A hypothesis was put forward and the result showed that the variables were independent of each other and that the users viewed the attributes distinct. This allowed the application of multiple comparisons. The multiple comparisons pointed out the pattern of distribution in the survey and brought out the key trust attributes from user view of trustworthiness.

5.3.7 Statistical Analysis of the Survey Results and the Methods

To achieve the objective of this chapter, it was necessary to adopt a statistical method that could accommodate as many of the 14 data groups of the attributes of trustworthiness and could also be suitable for data sets on an ordinal scale resulting from ranking. Therefore, a non-parametric statistics tool with the capability of data ranking was considered appropriate for the analysis.

The most acceptable and widely used non-parametric tests are the Mann-Whitney non parametric test; which is suitable for testing 2 samples, the Wilcoxon parametric test for testing 2-paired samples and the Kruskal-Wallis statistics for testing samples that are greater than 2 in number (McDonald, 2009). The approach chosen for this analysis was

the Kruskal-Wallis One-way analysis of variance by rank because it can be used for more than 2 groups of data or samples.

5.3.7.1 Kruskal-Wallis One-Way Analysis of Variance by Ranks Test

The Kruskal-Wallis One-way Analysis by Variance is a simple and easy to use statistical non-parametric method. There are several benefits for using the Kruskal-Wallis One-way Analysis by Variance to test if attributes have an identical distribution. It can be used to determine whether 3 or more groups are similar or differ in some variables of interest. It does not assume that the data are normally distributed. This method can accommodate ranked data, so the measurements of the observations are converted to their ranks in the overall data set. It also incorporates group uncertainty when comparing data and can be used for ranking all the data that originate from the same distribution together from 1 to N and ignoring the group membership(Daniel, 1997). The analysis was performed using Strata. Table 5. 3 provides the results from the test.

The Kruskal-Wallis Statistics is given by:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{1}{n_i} \left[R_i - \frac{n_i(N+1)}{2} \right]^2$$

Where:

n_i: is the number of observations for each attribute (attribute *i*)

N: is the sum of all the observations and

R_i: is the sum of the ranks assigned to observations in the i^{th} sample

The above statistics (formula) gives the chi square values shown in the statistics.

For the purpose of analysis, the 14 attributes were coded as presented in Table 5.3. The coding was same as those assigned to each attribute during the survey.The number assigned to each attribute is used in the statistical testing in the place of the attributes.

Table 5.3: Coding of the 14 attributes of trustworthiness

Assigned No.	Corresponding Attributes
1	Predictability
2	Accessibility
3	Safe and secured
4	Fast response time
5	Attractive appearance
6	Verifiable information
7	Availability
8	Detailed operation information
9	Good reputation
10	Accuracy
11	Well-known and widely used
12	Easy to use
13	Clarity of Information
14	Privacy

5.3.7.2 The Hypothesis Testing

On the bases of the results presented for the statistical testing:

$\mathbf{H_0}$: Shows that the items have identical distribution

$\mathbf{H_1}$ Shows that the items do not have identical distribution

If the result from the test leads to the acceptance of the null hypothesis ($\mathbf{H_0}$) then the attributes have identical distribution, which shows that the system users view all the attributes in the same manner. If the test supports an alternate hypothesis ($\mathbf{H_1}$), then the attributes do not have identical distribution therefore, the systems users view each attributes as distinct.

The Probability Value (p-value)

The probability value represents the level of marginal significance within the statistical hypothesis test. It is used as an alternative to rejection points in order to provide the smallest level of significance at which the null hypothesis will be rejected. The smaller the probability value, the stronger the evidence is in the favour of the alternative hypothesis.

Table 5.4: Rank sum used in computing the Kruskal-Wallis statistics and the computed chi-square value

Attributes	**Response count**	**Rank Sum**
1	216	332100.00
2	253	387189.50
3	401	311573.50
4	239	391358.50
5	171	405940.50
6	194	361321.00
7	210	359241.00
8	132	271509.00
9	209	385340.00
10	246	369699.00
11	158	285091.00
12	240	423984.00
13	152	271516.00
14	312	350418.00
Chi-square value		637.747
Degree of freedom		13
p-value		0.0001

Table 5.4 shows a p-value = 0.0001 which is less than the 5% or 1% predetermined significance level. This presents very strong evidence that favours the alternate hypothesis (**H_1**). The implication is that the difference between each attribute as perceived by the subjects is very strong and significant. Consequently, the H_0 (null hypothesis) is rejected implying that the responses on the attributes do not have the same median or the same distribution. The implication is that the subjects perceived all the attributes in different ways, which shows that the subjects treated each attribute separately. Therefore, what a user views as an important attribute does not imply they view any other attribute as being equally important.

The Kruskal-Wallis Test is unable to carry out multiple comparisons to determine which of the 14 attributes have identical distribution, if any. It can only tell whether there is a significant difference between two or more groups but does not identify which one of the groups differ. It is therefore unable to show the pattern of the response and the distribution and the inter relationship between the attributes and how they are grouped together. Therefore, multi-comparison test is required to solve this problem.

5.3.8 Multiple Comparisons

Multiple comparisons arise when a statistical analysis indicates significant differences in a number of items and there is the presumption that the strongest difference among all the comparisons made will be given more recognition (Westfall and Young, 1993; Daniel, 1997). The interest in multiple comparisons was developed by Turkey and Scheffe in the 1950s and had a tremendous growth for about two decades before experiencing a decline. In the 1970s and 1980s, new procedures and ideas came out and the interest in multiple comparisons continues to increase.

Multiple Comparisons are a group of tests that follow from the results of statistical tests that compare a number of items, usually greater than 3. Such a test could be one or two-factor ANOVA or the Kruskal-Wallis test as used in this study. Multiple comparisons can only be carried out if significant differences have been found. They provide more information that may be lacking in the Kruskal-Wallis or ANOVA (Demsar, 2006;

Daniel, 1997). The purpose of carrying out a multiple comparison test in this research after using the Kruskal-Wallis is to determine the subsets of the attributes that are identical after the test statistics has shown that there is a significance difference. The procedure exposes interesting relationships between the data set and confirmatory evidences regarding the hypothesis tested.

There are a wide variety of multiple comparison methods for statistical testing but they differ in a number of ways. An appropriate procedure is chosen depending on the specific situation of statistical testing. Some frequently used multiple comparisons are: Tukey-Kramer Method (Tukey's HSD), Scheffe method,, Duncan's new multiple range test, The Nemenyi test, The Bonferroni-Dunn test, Student Newman-Keul post-hoc analysis, Dunnett's test (Daniel, 1997; Demsar, 2006; McDonald, 2009). The multiple comparison chosen for this research is the Bonferroni-Dunn test because it can enable this research to identify the key trust attributes that can enhance user perception of information system trustworthiness. The Bonferroni-Dunn test can be applicable for non-parametric tests (Daniel, 1997), as the same applies to this research.

5.3.8.1 The Bonferroni-Dunn test

For the purpose of this research, the Bonferroni-Dunn test was chosen for further analysis because it is used specifically for non-parametric statistics to compare any significant difference in mean or medians based on ranking (Demsar, 2006). It can be used in the analysis of variance when the number of comparisons is not large. It is able to show whether there is significant difference between the groups and can also identify which of these groups differ from each other. When it is applied to the result from the survey, it can show the pattern of response.

Dunn's work was one of the earliest attempts to provide researchers with a way to select, and test a number of contrasts from among a set of mean scores. It is sometimes referred to as the Bonferroni because it uses the Bonferroni PE correction procedure in the determination of the critical value of significance (The PE correction signifies the Per Experiment error rate) (Demsar, 2006). Adopting Dunn's test meant that interested

researchers no longer needed to test all possible comparisons, but only a few test of interest. Based on these objectives, this section compares the significance differences in mean based on ranking.

For the multiple comparisons, the statistics by Dunn (1968) used is given by:

$$\left|\bar{R}_i - \bar{R}_j\right| \leq Z_{(1-[a/k(k-1)])}\sqrt{\frac{N(N+1)}{12}\left(\frac{1}{n_i}+\frac{1}{n_j}\right)}$$

Where

N is the number of all observations

$n_i$is the number of observations in attribute i

$n_j$is the number of observation in attribute j (for attribute i and j to be compared)

$\bar{R}_i$is the sum of ranks assigned to observations in the ith sample

$\bar{R}_j$is the sum of ranks assigned to observations in the jth sample

Z is the value obtained from the standard normal table at alpha levels of significance and is signified by$Z_{(1-[a/k(k-1)])}$

k-1 is the degree of freedom

$\left|\bar{R}_i - \bar{R}_j\right|$ Is the difference

Any difference$\left|\bar{R}_i - \bar{R}_j\right|$ that is larger than the right hand side of the above inequality is declared significant at α (alpha) level. The α level signifies the error rate per comparison

Table 5.5: Results from the Bonferroni-Dunn Multiple Comparison Test

Attributes	No of Response	Similar attributes based on mean rank					
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
3	401	776.99					
14	312		1123.13				
10	246			1502.84			
2	253			1530.39			
1	216			1537.50			
4	239			1637.48	1637.48		
7	210			1710.67	1710.67		
12	240				1766.60		
13	152				1786.29		
11	158				1804.37		
9	208				1852.60		
6	194				1862.48		
8	132					2056.86	
5	171						2373.92

The Multiple comparison tests is to examine attributes that have similar median or mean (ranking) based on a non-parametric procedure developed by Dunn (1964). The result classifies the 14 attributes into 6 different groups as shown in table 5.5. Group 1 is the most important group from the user perspective. Group 2, is the next most important followed by Group 3 and so on until Group 6, which is the least important group from the perspectives of the users. Similarity defines a condition of being similar, or having resemblance. It defines likeness, equivalence or having corresponding attribute(s).

5.3.8.2 The Test Result

This section shows the statistical findings for each statistical group. From the pattern of the distributions, Group1 has the strongest mean rank value. The group contains the most important attribute of a trustworthy information system. It contains only one attribute; the Safe and Secure attribute with a mean rank of 776.99. It is not similar to any other attribute and it stands alone, signifying that safe and secure can be considered a major attribute of trustworthiness. Group 2 was rated the second most important attributes and is made up of one attribute 'Privacy'. It is not similar to any other attribute in the survey and stands alone. It has a strong mean rank of 1123.13 that shows that the majority of the subjects would want privacy when using an information system.

Group 3, has the third most important attributes in the survey. There are 5 similar attributes in this relationship. The attributes and the mean rank in a descending order are as follows: Accuracy has the strongest mean rank in the group with a value of 1502.84 and is followed by Accessibility with a mean rank of 1530.39; Predictability has a mean rank of 1537.50 while the mean rank for Fast and response time is 1637.48. The last in the group is Availability with a mean rank of 1710.67.

Attributes in Group 4 came fourth in the rank from the perspective of the subjects. It is made up of 7 similar attributes. The first two attributes had the strongest mean rank value in the relationship and they also belonged to group 3, but have the weakest mean rank value in group 3 relationship. They are fast response time with a mean rank of 1637.48 and Availability with a mean rank of 1710.68. The remaining 5 similar attributes and their corresponding mean rank values are: Easy to use with a mean rank of 1766.60, Clarity of information with 1786.29. Well known and widely used has 1804.37 mean rank value and Good Reputation has 1852.86. Verifiable information had the weakest relationship in the group with a value of 1862.48.

Group 5 has only one attribute that is not similar to any other attribute in the survey. The attribute is 'Detailed Operation Information'. It stands alone in the survey and has a very weak mean rank value of 2056.86. This shows that only a limited number of the subjects

that took part in the survey are interested in this attribute. Similarly, Group 6 also has one attribute and not similar to any other attribute in the survey. It is 'Attractive appearance'. It has the weakest mean rank in the entire statistic with a value of 2373.92.

5.3.7.3 The Key Trust Attributes from the multiple comparisons result

The results from the multiple comparisons showed how the responses were grouped and the pattern of distribution. The variables that have the strongest mean values have the smallest figures and vice versa. Additionally, the results showed that there are significant differences between the six groups. Group 1, 2 and 3 have the strongest mean value with group one being the strongest. Group 4, 5 and 6 have the weakest mean value with group 6 being the weakest.

This thesis is focused on the use of the result from the multiple comparisons that stemmed from the survey to determine the attributes that system users consider to be the most trustworthy attribute in their perception of system trustworthiness. Despite the 14 attributes used for the survey, this thesis identifies 6 of the attributes as the most important attributes that can be used to model trust in the systems design process of an information system because they have the strongest mean value. Therefore, the attributes that are considered as most important attributes to model trustworthiness represent the variables that have the strongest mean value. They are shown in table 5.6.

Table 5.6: The Attributes of trustworthiness considered most important

S/N	Attributes	Mean Rank
1	Safe and Secure	776.99
2	Privacy	1123.13
3	Accuracy	1503.84
4	Accessibility	1530.39
5	Predictability	1537.50
6	Fast Response Time	1637.48

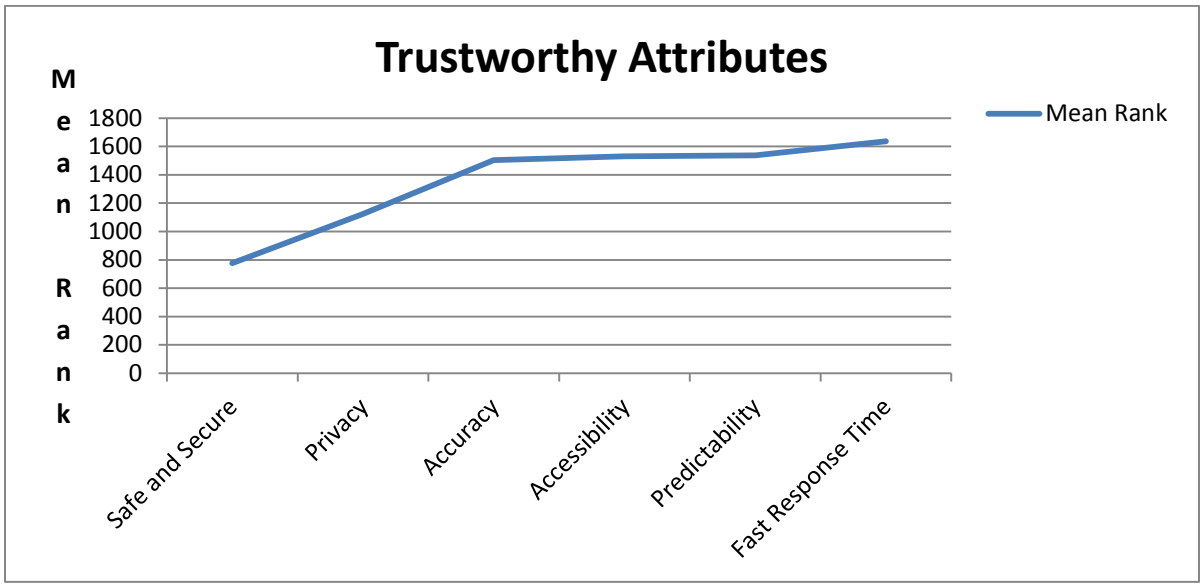


Figure 5.3: Graph Showing the Key Attributes of System's Trustworthinessand the corresponding mean rank values

The results from the statistical tests suggests that 6 attributes out of the 14 attributes used for the survey, are the key attributes that users perceive as having more significant impact on system trustworthiness. They are Safe and Secure, Privacy, Accuracy, Accessibility, Predictability and Fast Response Time (figure 5.3). This does not suggest that the remaining 8 attributes do not have any significant impact on system trustworthiness. However, this thesis suggests that these 6 key attributes should not be neglected in any design process of an information system.

5.4 Chapter Summary

The research objective of this chapter was to find out the most important or the key trust attributes that can increase user perceptions of an information system's trustworthiness An online survey method and some statistical analysis were carried out to fulfil this objective. A preliminary study was made prior to the research survey to improve the efficiency of the research survey. This chapter provided the description of the survey, the responses from the survey and the statistical testing.

This chapter started by introducing the survey technique that was employed. The method was Survey Monkey, an online method that is known for its speed, ease of use and accessibility qualities (Burgess, 2001). The 14 attributes of trustworthiness from the previous chapter, obtained from theories, models, frameworks and empirical studies were used for the survey. The subjects were asked to rank the 14 attributes of trustworthiness in the order of importance from rank 1 to rank 6 and rank 6 being the most important attributes. The survey results were gathered, presented and statistically analysed.

The purpose of the statistical testing was to quantitatively analyse the data from the survey to find out the key attributes that could influence user perceptions of system trustworthiness. To achieve this, the Kruskal-Wallis one-way analysis of Variance by Rank was adopted because of its suitability. The results from the statistical testing led to the rejection of the null hypothesis in favour of the alternate. This showed that there was significant difference between the distributions of the data groups. The implication of this is that the respondents were independent in their choice of attributes, and that the subjects had different perspectives on the attributes of system trustworthiness. The next step was to apply the multiple comparisons for statistical testing in order to find out the most important attributes of trustworthiness.

The Bonferroni-Dunn Multiple Comparison Test was employed to compare the significant difference in mean rank for all the variables that signified the attributes of trustworthiness. The results showed the pattern of distribution of the survey. The pattern of distribution exposed the variables with the strongest mean value. It also exposed the similarities and differences between the attributes.

The attributes fell into 6 groups. The first group had the strongest mean and the last group had the weakest mean. The attributes that had the strongest mean value were chosen to represent the most important attributes of system trustworthiness. They were 6 attributes and are safe and secure, privacy, accuracy, accessibility, predictability and fast response time. These attributes can serve as the key attributes of trustworthiness that can enhance user perceptions of trust in systems design and can be used to model trust in the system design process of an information system.

The aim of this thesis is to identify the factors that can enhance user perceptions of information systems trustworthiness, and how these factors can be modeled into a system design process to create systems that are perceived trustworthy. The results from the survey and statistical testing show that trust is not a one size fit all when it comes to system design. What will be a set of values for one system may not be the same for another system e.g. banking system that require safe and secure, and social media that require attractive appearance. Different systems may require different attributes for trustworthiness. The statistical analysis of the survey data identified 6 key attributes of trustworthiness, and modeling these six attributes within the design of an information system can produce a system that users perceive as trustworthy.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Introduction

This chapter gives an overview of work done throughout the entire period of research. The aim of this thesis was to identify what factors affect user perceptions of the trustworthiness of an information system and to find out how that knowledge can be modeled into a system design process, to create systems that are perceived as trustworthy.

To achieve this aim, it was necessary to look at some trust concepts alongside some trust definitions that relate to both human-to-human trust and human-to-system trust. Trust was considered as an essential part of social and individual human life, while the basis for trust was seen as the foundation for any trust relationship. The concept of trust was investigated from a multidisciplinary perspective with focus on the social sciences because the social perspectives connect with the objectives of this research. Moreover, trust is viewed as one of the most important elements of social reality that captures any form of relationship (Horsager, 2011; Lewis and Weigert, 1985). A review of several journals, conference papers and books was undertaken to get a broader picture of trust and its related concepts.

This research showed that system designers and developers might have different understanding of what systems' trustworthiness may be and therefore, their perceptions of system trustworthiness maybe different from user perceptions of trustworthiness. They need the knowledge of what will enhance user trust within a technical setting in order to design systems that users can perceive trustworthy. This thesis provides the overview of the findings that can assist towards the realisation of this goal. To this end, this research carried out detailed investigation into the key attributes that can enhance user perceptions of information system trustworthiness.

A critical review and analysis of information system design methodologies (ISDM) was undertaken to investigate the inherent features that could either promote or impede trust. This presented some gaps that could lead to potential discovery of new approaches to improve trust features in system design processes. It prompted an information system survey and statistical analysis that assisted in identifying the key trust factors that could assist to bridge the gaps in the system design process. The key trust factors were the key trustworthy attributes for system design and this was a major step in the realisation of this research aim.

6.2 The Research Findings and Fulfillment of the Research Objectives

This section explains how the research aim and objectives have been met directly. It also explains how the research questions have been answered.

- **Objective one: to carry out research into trust and its related concepts**

The issue of trust and its related concepts has been examined with adequate literature support in Chapter 2. This was done with the view of answering the research question of "how can the concepts of trust be understood and how can they be integrated into human-system relationships?" During the process of fulfilling this objective, several concepts of trust were identified and reviewed. This was done with the aid of relevant literature on the subject. The first step to understanding the trust concept was to understand the foundations for any trust relationship. In chapter two, it was referred to as the bases for trust. They are institution-based trust, knowledge based trust, calculative-based trust, characteristics based trust, affective based trust and cognitive based trust. Each of these bases for trust attracts some trust definitions. There were several elements of trust that were seen in each of the bases of trust and the most common elements that were present in all trust relationships and that applied to this research were expectations, risk, reliance and vulnerability. The relationships between them were examined.

In an attempt to give a wider view to the concept of trust, chapter two investigated the concept of trust from a multidisciplinary perspective. Trust was captured from various dimensions, including psychological, sociological and economical perspectives. These presented a wider view of trust. However, the concept was narrowed down to trust as an element of social reality that can capture any form of relationship between people and information systems.

Within the information system domain, trust was defined as the willingness of a system user to be vulnerable to the actions of an information system, based on the expectations that the system will behave satisfactorily, irrespective of monitoring or controlling the system. This definition stemmed from the literature review. This led to finding the similarities between human-to-human trust and human-to-system trust. The findings showed that information systems can reciprocate trust directly to users and can act as a mediator between humans. Therefore, systems can exhibit the qualities of trustworthiness.

There were two concepts of trust in information systems that attracted much attention in chapter two. They came under the notion of information system usage. They were the concept of initial trust and trust that develops when a user becomes familiar with an information system. The determinants of initial trust discussed were propensity to trust, the physical design of an information system, perceived usefulness of a system, motivation, reputation, information system quality and social pressure. It was acknowledged that the determinants of initial trust also apply to trust that develops after a user becomes familiar with an information system. Two other factors that were examined in addition to those factors were user effectiveness with information systems and user prior experience with information systems. Initial trust and trust that develops due to continuous use of information system stem from human-system-relationship.

- **Objective number 2: to identify the trust attributes from theories, models and empirical studies in information systems.**

To meet this objective, the research questions of how system users perceive information system trustworthiness was answered. Also examined in this direction was the question

"how can the trust attributes be determined?" The first step towards answering these questions was accomplished in the later part of chapter two. The second part of chapter 2 concentrated on some information systems theories and models and how they dealt with trust and trustworthiness. They were the Witness Based Theory, Thriving System Theory and the Delone and McLean Information System Success Model (D and M IS Success Model). The Witness Based Theory dealt with how user experience and the testimonies of others who have had some experiences with the same system influence user perceptions of that system's trustworthiness. The Thriving Systems Theory discussed the need for an information system to be designed based on the expectations of all its prospective users and stakeholders. It emphasises that a system that fulfills user expectations can enhance their perception of trustworthiness. It proposes that user and stakeholder involvement in systems design is a means to capture requirements. The D and M IS Success Model showed that information system quality is critical to understanding trustworthiness and subsequently, the success of an information system. These three models provided the initial steps needed towards the understanding of user perception of trust in information systems.

Chapter 3 opened with investigating the attributes that make users perceive an information system as trustworthy. These attributes of trustworthiness represent the factors that can enhance trustworthiness. It answered the research question of "how can trust attributes be determined?" The D and M IS Model was distinguished as the model that best described user perceptions of information system trustworthiness. The attributes of trustworthiness fitted well with its quality dimensions. Secondly, quality is known to enhance trustworthiness and can aid user perceptions of trustworthiness (April and Pather, 2008; Aris et al, 2011; Hussain, 2007).

As part of satisfying the research objectives, several quality factors were gathered from empirical studies in Chapter 3. Out of the proliferation of these, fourteen attributes were captured, scrutinised and defined. They represent the attributes that users perceive to enhance system trustworthiness. They are: accessibility, accuracy, attractive appearance, availability, clarity of information, detailed operation information, easy to use, fast

response time, good reputation, predictability, privacy, safe and secure, verifiable information and well known and widely used. An overview of how these attributes relate to the quality dimensions of the D and M IS Success Model was discussed.

The research question of "how do system users perceive system trustworthiness?" was examined in chapter 3. In addition, the chapter contributes toward meeting the second research objective of carrying out a study of trust attributes from theories, models and empirical studies as part of meeting the research aim of investigating the factors that can enhance user perceptions of system trustworthiness.

- **Objective Three: to investigate current Information System Design Methodologies (ISDMs) and identify some gaps in the current state of the art with respect to promoting the trustworthiness of systems**

The review of Information System Design Methodologies (ISDMs) was done in Chapter 4 to identify some gaps with the view to promote trust in system design. The purpose of this was to assist towards meeting the research aim of identifying what is lacking in system design that designers might incorporate to increase user perception of system trustworthiness.

In Chapter 4, it was discussed that the number of methodologies were constantly on the increase. The number was estimated to be over a thousand about two decades ago (Jaryarantha, 1994) and this was expected to have doubled by now. It was explained that researchers and fieldworkers agreed that there is no single methodology that could be applied to every system design (Yeghini, 2009). Therefore, organisations select appropriate methodologies that suit them and that could facilitate their processes of system design. Every ISDM belongs to a particular class based on their features, models and specific concept. Therefore, for the purpose of clarification and in line with the literatures reviewed, ISDMs were classified into 5 major methodology classes. They were the structured methodologies, the object oriented methodologies, the participatory methodologies, the prototype methodologies and the agile.

To achieve the third objective of this research, the investigations of ISDMs started chronologically from the later part of the 20th century, when the first ISDMs were universally accepted until this present era. The structured methodologies dominated system design during the first generation of approaches while the object-oriented methodologies dominated the second generation. The third generation was dominated jointly by the participatory and the prototyping approaches. The last and present generation is dominated by the agile. The principles, procedures, techniques and tools of each class were discussed and, thereafter, one methodology from each class was introduced.

As part of fulfilling the research objectives, the strength and weaknesses of each methodology and how trust is featured were investigated. The strength and weaknesses were investigated based on the principles, phases, procedures, activities, and techniques of each methodology. The features of trust were investigated based on the 14 attributes of system trustworthiness captured in chapter 3. During the process of investigation, gaps where identified and analysed on how trust was featured in each ISDM. The findings showed that each ISDM featured trust differently and that no class of ISDM had all the trust features present in their system design. It also showed that many organisations are aware of these gaps, therefore they have developed their in-house methodologies to bridge the gaps.

The identification of gaps in ISDMs with respect to promoting trust in information systems design answered the research question of how methodologies feature trust in their system design process. This was achieved in chapter 4 and contributed towards the aim of this research.

- **Objective Number 4: to identify the key trust attributes that can enhance user perceptions of information system trustworthiness.**

Chapter 3 of this thesis showed that user perception of an information system's trustworthiness depends on a number of attributes exhibited by that system. Those attributes determine the purpose of such information system. They vary from system to

system depending on the core objectives (Avison and Fitzgerald, 2006). Moreover, the core objectives of any system are determined at the initial stages of its design process. As discussed earlier each methodology features trust differently depending on its objectives, and no class of methodologies has all the trust features present during system design. For instance, a database management system, an e-learning system, a transaction processing system exhibit different attributes based on their core objectives. Chapter 3 identified fourteen attributes of information system trustworthiness.

It may not be necessary to model all the fourteen attributes of system trustworthiness before a system is portrayed as trustworthy. A user can expect satisfaction based on the attributes of an information system and there may be no borderline as to what attribute is perceive as trustworthy by a user. Trustworthiness can be derived from the level of satisfaction a user derives from an information system in fulfilling expectations. Additionally, the attributes that a user perceives as trustworthy in a particular system may not be perceived as trustworthy in another system by the same user. Therefore, it may not be necessary to model all the fourteen attributes of trustworthiness in the system design process before a system can be perceived as trustworthy.

Chapter 5 identified the key trust attributes that could enhance user perceptions of system trustworthiness through an information system survey and statistical testing. The information system survey was carried out using an online survey method based on the fourteen identified attributes of trustworthiness. The subjects who participated were not compelled to take part and were free to withdraw at any point. Five hundred and twenty-two (522) system users participated fully in the survey. The subjects were asked to select 6 most important attributes from the 14 attributes and rank them in the order of importance. Rank number 6 being the most important quality and rank number 1 represented the least important attribute of the 6 attributes chosen. The results from the survey were collected and analysed statistically. The analysis was aimed at bringing out the key trust attributes of trustworthiness from system user perspectives.

Data from the survey were used for statistical analysis and for multiple comparisons. The Kruskal-Wallis One-Way Analysis of Variance by Rank was used for the statistical

testing while the Bonferroni-Dunn Test was used for the multiple comparisons. The statistical analysis by Kruskal-Wallis One Way Analysis of Variance was used to find out if each of the attributes selected by the participants had the same probability as the others. That is, if they were identically distributed and mutually independent. This led to hypothesis testing. The null hypothesis ($\mathbf{H_0}$), showed that the attributes have identical distributions, but an alternative hypothesis ($\mathbf{H_1}$), showed that the attributes do not have identical distributions. The result disproved the null hypothesis ($\mathbf{H_0}$). Therefore, the results implied that each system user independently selected the attributes. Moreover, there is no relationship between the attributes being selected.

A collection of all the user views of the most important attributes was needed for multiple comparisons to determine the top ranking attributes that could represent the key trust attributes of trustworthiness. The Bonferroni-Dunn Test was used for the multiple comparisons. It exposed the similarities and the differences between the attributes and the pattern of distribution during the survey. From the results of the multiple comparison, the attributes with the strongest mean values ranked highest for trustworthiness from the users' perspective. There were 6 attributes that were recognised as the most important attributes or the key attributes that can enhance user perceptions of trustworthiness in any information system. They are: safe and secure, privacy, accuracy, accessibility, predictability and fast response time.

6.3 Research Contributions

This thesis has contributed to the body of knowledge. The contributions from this thesis are explained as follows:

- **Recognising and exposing the hindrances and limitations in user perception of information system trustworthiness**.

This thesis has reviewed some contemporary literatures, theories, models and empirical studies that deal with the concepts of trust both in general terms and trust in information systems. During investigation, it was found that there are challenges and limitations in

the current state of the art with respect to user perceptions of information system trustworthiness. Although there has been lots of attention on human-to-system trust, most of the literature has been constructed with limited or no attention to user perceptions of information system trustworthiness. Notwithstanding, user perceptions of information system trustworthiness can influence their acceptance and subsequent use of systems. However, this thesis recognises these limitations and challenges. Consequently, it contributes to knowledge by researching several trust literatures to uncover the fundamental factors that underpin user perceptions of information system trustworthiness.

- **Exposing the gaps that undermine trust in Information System Design Methodologies**

A further contribution is a review of the gaps in Information System Design Methodologies (ISDMs) regarding trustworthy requirements during system design. As was observed whilst chronologically reviewing and investigating the existing ISDMs, it was identified that there is a plethora of them. Each evolved with a particular philosophy, characteristics, tools and approaches to system design. Additionally, how each class of ISDM promotes or impedes trust was critically investigated and analysed. During this process, it was observed that despite the continuous evolvement of methodologies over the years, there are gaps in trustworthy requirements for each class of methodologies investigated.

This review contributes to the body of knowledge by highlighting the limitations in ISDMs with respect to modelling trust during system design. New approaches could be developed to address these gaps by working out the factors needed to create systems that can enhance trust perception.

- **The identification of some key attributes that organisations need to integrate into system design methodologies to increase user perspectives of their system's trustworthiness**

This thesis was able to identify some attributes of system trustworthiness from user perspectives during the literature review. There were a large number of attributes

obtained because the attributes came from several information systems theories and frameworks. An approach was needed to bring out the most important or key trustworthy attributes for system design. This prompted an information system survey and statistical testing. The results from the survey and statistical analysis suggested the key attributes that can be used to enhance trust perceptions in any information systems design.

During the review, this research identified that in most system design processes, trustworthiness was often designed as a single attribute to serve the core objectives of a system whereas some systems may be lacking in other major attributes that could enhance trustworthiness. The core attributes can assist a system to fulfil its aim but may not enhance the perception of trustworthiness. The key attributes identified can provide a foundation for trust to be modeled into system design alongside core objectives, such that users can perceive the system trustworthy.

- **The diverse understanding of systems trustworthiness by different individuals**

This thesis contributes to the body of knowledge by providing a better understanding of how different individuals perceive and understand trustworthiness. This was done by bringing in different theories of trustworthiness and analysing them. It also shows how an individual's understanding of trustworthiness relates to his or her personal experiences with information systems. The theories and models considered in the study were used to expand on this. Additionally, the outcome of the survey conducted in the course of this research showed how different individuals choose their trustworthy attributes differently from each other and each individual's choice was based on his or her personal experiences and relationships with information systems. This agrees with the findings from the reviews and the statistical analysis.

Despite the growing interest in trustworthy systems amongst researchers and field workers, the subject of how information system trustworthiness is perceived by different individuals is not receiving adequate attention and this is the area that this research has addressed.

- **The exposing of limitations in current literature on trust modeling in information system design**

This research contributes to the body of knowledge by showing that there are limitations in the current trust literature with respect to modeling trust in information system design and development processes. Therefore, this research contributes by exposing those limitations giving room for further studies on how to bridge those gaps.

6.4 Research Limitations

This thesis has contributed to the body of knowledge. However, despite the contributions, there are a number of limitations associated with the work and need to be highlighted.

- **Limited attributes that convey trustworthiness**

After the examining the attributes that enhance trustworthiness, 14 attributes were identified as attributes of trustworthiness. However, attributes that support trustworthiness are not limited to 14 attributes. The actual number of trustworthy attributes may not be known because some systems may contain other attributes that are exclusive of the 14 attributes considered.

- **The population used for the survey and the sampling technique**

The survey conducted was focused particularly on university students, academic staff and administrators in 3 campuses of the same university. This might not be a true representation of the entire users of information systems in different settings. It would have been interesting to extend the survey to other types of organisations and communities both in the developed and developing countries. A study such as this might provide somewhat different user perspectives on information system trustworthiness that may lead to a different view of the 6 attributes of trustworthiness.

- **The validity of the attributes of trustworthiness**

The framework to integrate trust into system design has not yet been developed to check the validity of the key attributes of trustworthiness in assessing user trust perception.

6.5 Future Work

This research could be taken forward in a number of ways. This section discusses some recommending areas for further studies or for more investigations.

- **Foundation for future study**

This thesis provides a foundation for further research into information system trustworthiness from the user perspective. The result from the survey can be used for an in depth study on systems trustworthiness from the user perspective. Further work will seek to expand upon this investigation with experimental investigations and case studies that can uncover the processes by which some key trust attributes are integrated into systems design in a way that can positively influence user perspectives of system trustworthiness.

- **To propose a framework for modelling trustworthy requirements for information systems design**.

The attributes that were investigated can be used to build a framework that can assess trustworthiness at any level of system design and development. Because current methodologies involve users in their system design and development, this framework will enable everyone involved to predict system behaviour in accordance with user expectations of trustworthiness. The trust framework will capture trust requirements from the user perspective and also assess and monitor system performances during system design. The framework can serve as a guide for system design.

- **To test how well the proposed framework can assess system trustworthiness during system design.**

The framework proposed to integrate trust into system design would require testing to see how well it can assess user perceptions of system trustworthiness. This would be possible in situations whereby users take part in systems design from the requirement stage and throughout the design and development processes. This will involve the development of a prototype that can incorporate the attributes of trustworthiness during system design and development processes.

- **The need to explore further the required information for trust modelling in system design**

Another area for future studies is the need to explore further the required information in a context that is beyond the scope of this research. This can include going beyond the university population within the United Kingdom as used for the survey, to include other members of the public in rural areas and outside the United Kingdom. They can potentially generate new dimensions to extend the concepts of trustworthiness in a more elaborate manner.

6.6 Final Statement

This research has been able to achieve its main aim that was to identify the factors that could enhance user perceptions of information system trustworthiness and to find out how these can be modeled into the system design process of an information system. This chapter opened by describing the work done within the chapters of this thesis that cover the research objectives and the research questions. The major contributions of this thesis to the body of knowledge were discussed and some ways that this research could be taken forward. Although there were some limitations to this thesis, the findings represented reveal how user perceptions of trustworthiness can be used to enhance their trust in information systems and their design processes.

Appendix A1and A2: Attachments to Chapter 3

A1: Quality Factors from models, frameworks, and their authors

Quality Factor	Authors
➢ Believability ➢ Accuracy ➢ Objectivity ➢ Timeliness ➢ Relevancy ➢ Completeness ➢ Appropriate Amount of Data ➢ Interpretability ➢ Verifiability ➢ Consistency	Wang and Strong (1996)
➢ Timeliness ➢ Completeness	Gertz(1996)
➢ Accuracy ➢ Ease of Use ➢ Objectivity ➢ Orientation ➢ Currency ➢ Authority	Alexander and Tate (1999)
➢ Privacy ➢ Presentation ➢ Content ➢ Quality of values	Redman(1997)
➢ Consistency ➢ Accuracy ➢ Completeness ➢ Usefulness	Corbitt et al(2003)
➢ Accessibility ➢ Contextual ➢ Intrinsic ➢ Representational	Lin et al (2007)
➢ Ease of Use ➢ Usefulness	Davis (1989)
➢ Credibility ➢ Communication ➢ Responsiveness ➢ Reliability ➢ Tangibles ➢ Security ➢ Courtesy	Zeithalm et al (2002)
➢ Competence ➢ Access ➢ Understanding	
➢ Appearance ➢ Availability ➢ Cleanliness ➢ Comfort ➢ Communication ➢ Competence ➢ Courtesy ➢ Friendliness ➢ Reliability ➢ Responsiveness ➢ Security	Johnson(1995)
➢ Response Time ➢ Visual Appearance ➢ Information fit to task ➢ Interaction ➢ Trust ➢ Interaction communication ➢ Intuitiveness ➢ Design ➢ Innovation ➢ Emotional appeal ➢ Business process ➢ Substitutability	Loiacono et al(2002)
➢ Competence ➢ Access ➢ Courtesy ➢ Communication ➢ Credibility ➢ Security ➢ Physical appearance	Parasuraman et al (1985)
➢ Ease of use ➢ Physical Appearance ➢ Linkage ➢ Structure layout ➢ Content ➢ Reliability	Gronroos(1984)

➢ Efficiency ➢ Support ➢ Communication ➢ Security ➢ Incentives	
➢ Location ➢ Layout ➢ Décor ➢ Size ➢ Facility ➢ Reliability ➢ Process ➢ Flexibility ➢ Timeliness ➢ Speed ➢ Communication ➢ Courtesy ➢ Warmth ➢ Friendliness ➢ Tact and attitude ➢ Tone of voice ➢ Dress ➢ Neatness ➢ Politeness ➢ Attentiveness ➢ Anticipation ➢ Handling complaints ➢ Problem Solving	Heywood-Farmer (1988)
➢ Accessibility ➢ Appropriate Amount of information ➢ Ease of operation ➢ Free of error ➢ Interpretability ➢ Objectivity ➢ Relevancy ➢ Reputation ➢ Security ➢ Timeliness ➢ Understandability	Khan et al (2002)
➢ Reliability ➢ Efficiency ➢ Integrity ➢ Maintainability ➢ Usability ➢ Portability ➢ Reusability	`McCall(1977)
➢ Interpretability	
➢ Reliability ➢ Efficiency ➢ Integrity ➢ Maintainability ➢ Usability ➢ Portability ➢ Reusability ➢ Interpretability ➢ Clarity ➢ Modifiability ➢ Documentation ➢ Resilience ➢ Understandability ➢ Validity ➢ Generality ➢ Economy	Boehm et al(1979)

Appendix A2: Word Analysis

Word analysis: Each attribute was assemblage into different word groups that have similar interpretations. An attribute from each group was randomly selected as a representative; therefore, 14 attributes were selected. Arrows show word groups that are similar, but have slight differences in interpretations.

Predictability: Anticipation, Resilience, Consistency, Reliability.

Security: Authority

Fast Response Time: Speed, Responsiveness, Fastness, Timeliness,

Attractive Appearance: Physical Appearance, Structure Layout, Décor, Dress, Neatness, Attractiveness, Visual appeal, Representational, Emotional appeal, Design

Ease of use, Usability, Flexibility, Ease of navigation, portability, Modifiability, ease of operation, reusability, usefulness, maintainability,

Detailed operation of information: Appropriate Amount of Information, Content, Instructiveness, Appropriate amount of data

Privacy: Values, Integrity

Clarity of Information: Understandability, Communication, Understanding, Tone of voice, Complaints, Information fit to task, Interaction, Understandability,

Accessibility: Access

↕

Availability: substitutability

Accuracy: objectivity, credibility, Free of error,

↕

Verifiability: Documentation, Validity, Verifiability

Good Reputation: Courtesy, Warmth, Politeness.

↕

Well known and widely used: Generality, Relevance, Friendliness, Economy.

Appendix B, BI, B2 and B3: Attachments to Chapter 5

B: Responses for the Preliminary Studies

Attributes	**Responses**	**Percentage**
Predictability	2	6.67
Accessibility	1	3.33
Safe and Secure	9	30
Fast Response Time	3	10
Attractive Appearance	2	6.7
Verifiable Information	0	0
Availability	1	3.33
Detailed Operating Information	0	0
Good Reputation	1	3.33
Accuracy	2	6.67
Well Known and Widely used	2	6.67
Easy to Use	2	6.67
Clarity of Information	0	0
Privacy	5	16.67
Total	**30**	**100**

B1: The Information Sheet

1. Information sheet

My name is Helen Umoh, and I am an MPhil/PhD student with the School of Computing and Mathematical Sciences at the University of Greenwich. As part of my research, I am investigating user perception about what make a trustworthy information system. Answers from this investigation will be used to formulate questions for a further survey as part of my on-going research.

The survey has just one question and should take you no more than about 5 minutes to answer. What I would like you to do is to rank some qualities of information systems that are important for you to consider them trustworthy. Having answered the question, you are given the option to provide your name and email contact should you agree that we contact if you are prepared to be contacted regarding participation in a follow up survey in the future. Please rest assured that taking part in this first survey does not commit you to participate in any future surveys however, if you choose to provide us with your contact details then the personal information you provide will be kept confidential and only seen by me, no one else. It will only be used for the purpose of this research and will be destroyed at the end of this project.

Thank you for agreeing to take part in this survey. Please see the next page for the survey.

For further information about this study please contact:

Helen Umoh
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School of Computing and Mathematical Sciences
University of Greenwich
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B2: The Information System Questionnaire

1. From your own point of view, select the 6 most important qualities that an information system should possess in order for you to trust it. Rank them in the order of importance where 1 is the most important. If you have other qualities that you wish to use in your list, please do so.

	Most Important					Least Important
The system always behaves in a predictable manner	◯	◯	◯	◯	◯	◯
There are no problems with accessing the system	◯	◯	◯	◯	◯	◯
Information stored is safe and secured	◯	◯	◯	◯	◯	◯
The system response time is fast	◯	◯	◯	◯	◯	◯
The system has an attractive appearance	◯	◯	◯	◯	◯	◯
The information provided by the system can be checked	◯	◯	◯	◯	◯	◯
The system is available for use whenever the need arises	◯	◯	◯	◯	◯	◯
Detailed information is available to explain system operation	◯	◯	◯	◯	◯	◯
The system has good reputation	◯	◯	◯	◯	◯	◯
Information delivered by the system is always accurate	◯	◯	◯	◯	◯	◯
The system is well-known and widely used	◯	◯	◯	◯	◯	◯
The system is easy to use	◯	◯	◯	◯	◯	◯
Information is always communicated with clarity	◯	◯	◯	◯	◯	◯
An individual's private information is not publicly available	◯	◯	◯	◯	◯	◯

Other quality

2. Thank you for taking time to participate in this survey, if you would like to be involved in the next surveys on this topic, please provide your name and email address below:

B3: The Information System Survey Result

PAGE: INFORMATION SYSTEMS SURVEY RESULT

DownloadCreate Chart2. From your own point of view, select the 6 most important qualities that an information system should possess in order for you to trust it. Rank them in the order of importance where 1 is the most important. If you have other qualities that you wish to use in your list, please do so.

							answered question	**522**
							skipped question	**0**

	Most Important					Least Important	Rating Average	Rating Count
The system always behaves in a predictable manner	19.4% (42)	13.0% (28)	**20.4% (44)**	16.7% (36)	12.0% (26)	18.5% (40)	3.44	216
There are no problems with accessing the system	10.3% (26)	**24.9% (63)**	20.6% (52)	13.8% (35)	16.6% (42)	13.8% (35)	3.43	253
Information stored is safe and secured	**49.9% (200)**	26.4% (106)	9.0% (36)	7.2% (29)	4.7% (19)	2.7% (11)	1.99	401
The system response time is fast	6.7% (16)	17.2% (41)	**25.5% (61)**	21.3% (51)	15.1% (36)	14.2% (34)	3.64	239
The system has an attractive appearance	1.2% (2)	6.4% (11)	5.8% (10)	13.5% (23)	19.3% (33)	**53.8% (92)**	5.05	171

The information provided by the system can be checked	3.6% (7)	12.4% (24)	18.6% (36)	**25.3% (49)**	19.6% (38)	20.6% (40)		4.07	194
The system is available for use whenever the need arises	10.0% (21)	12.4% (26)	19.0% (40)	**22.9% (48)**	20.0% (42)	15.7% (33)		3.78	210
Detailed information is available to explain system operation	3.8% (5)	4.5% (6)	13.6% (18)	21.2% (28)	**35.6% (47)**	21.2% (28)		4.44	132
The system has good reputation	6.7% (14)	13.0% (27)	15.9% (33)	19.2% (40)	**23.6% (49)**	21.6% (45)		4.05	208
Information delivered by the system is always accurate	13.8% (34)	15.4% (38)	**23.6% (58)**	20.3% (50)	19.9% (49)	6.9% (17)		3.38	246
The system is well-known and widely used	12.0% (19)	10.1% (16)	15.2% (24)	17.7% (28)	**22.8% (36)**	22.2% (35)		3.96	158
The system is easy to use	9.6% (23)	13.8% (33)	16.3% (39)	20.0% (48)	20.0% (48)	**20.4% (49)**		3.88	240
Information is always communicated with clarity	8.6% (13)	12.5% (19)	19.1% (29)	17.1% (26)	**23.7% (36)**	19.1% (29)		3.92	152
An individual's private information is not publicly available	**32.1% (100)**	26.9% (84)	13.5% (42)	9.9% (31)	6.7% (21)	10.9% (34)		2.65	312

Thank you for taking time to participate in this survey.

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