Towards a human information interface for knowledge activities

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Declaration

I confirm that this is my own work and the use of all material from other sources has been duly and fully acknowledged.

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Michael Dzigbordi Dzandu

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I also thank my sister, Ms Olivia Akosua Kpodoe for her enormous contributions to my studies and personal development and Gargi Gupta for her advice.

"……to whom much is given, from him much is expected"

Luke 12:48

Dedication

This work is dedicated to God for the talents he has given to me; to my wife Cynthia and our three lovely gifts Ellis, Jesse and Michelle; and my parents especially my dad ESK Dzandu, who did not live to see the end of my PhD journey.

Abstract

This thesis set out to understand why there are context-deficiencies in stored data in information systems, and then developed a framework for building more context into the interface of information systems. Data stored in an information system is context lacking although it occurs in the environment often with associated context details such as “where”, “when”, “situation”, “how”, “who”, “why” and “what”. However, due to the limitations of current information systems, only limited context details mainly the “what” are usually captured as the “sign” and stored in the information system (as data fields with associated meta-data). The resultant context deficient data affects the understanding and usability of information when the data is subsequently retrieved from the information systems.

The study draws on semiotics theory, human computer interaction and context-aware literature to define human information interface, context-based data and information, and developed a context-based interface framework to enhance human understanding and usability of data or information stored in an information system. The lack of context in the ontology of data, i.e. as a key ingredient in information systems, is highlighted whilst introducing models that demonstrate the interrelationships between context-based data and the quality of data, information and knowledge with individual culture and interface factors as mediators.

Using design science research design, and a mixed methods approach, the problem of lack of context of data and information stored in information system and its impact on the quality of information and knowledge activities is demonstrated through three preliminary studies. A conceptual framework of human information interface, for information and knowledge activities, is first developed. Surveys and interviews are then used to demonstrate the mediating role of the human user and interface factors in human information interaction situations, leading to the refined context-based human information interface framework for knowledge activities.

A series of models are established and validated through structural modelling and path analysis, interviews, and together with case studies from expert reviews, the potential utility, validity and applicability of the framework is assessed. The results of the study did not only confirm the significance of the semiotics inspired interface factors and individual culture, when humans interface with information, but their mediating roles as well in human interaction with computer-based information systems. Consequently, the quality of data, information, and knowledge were affected by human factors and interface factors; and the design of context-based data and information interface for information systems were found to have a significant impact on the quality of knowledge activities. However, over 80% of the mediation effect was accounted for by the human factor, which emphasised the significant role of the human user in achieving optimum understanding and usability of stored data or information in information systems.

The thesis makes several contributions including the need for a paradigm shift from human computer interaction studies to human information interface studies in the face of the "disappearing computer". The concepts of human information interface (HII), and human-knowledge interface (HKI), which hitherto has not been defined in literature were defined. Another unique contribution of this study is the proposed multi-dimensional approach to the storage of data in information systems, specifically in 3 levels to represent the "what", "how" and "why" details to provide more context to enhance understanding and usability when data or information is retrieved from information systems. Other significant contributions are the introduction of the concepts of "context-store", "meta-why" and "meta-how", which together with the existing "meta-data" or "meta-what" can potentially help improve the human interface with information.

The main limitation of this study was the inability to design and implement the context-based interface for information systems in a real situation during the life of this thesis. This does not invalidate the outcome of the study, and considerable practical implications and relevance of the HII framework, for design of information systems and corresponding databases (i.e. information modelling and architecture, machine learning and deep learning, intelligence of context-aware and ubiquitous computing systems) are highlighted. In addition, future research directions are outlined for consideration.

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Related Publications

1. Dzandu, M. D., & Tang, Y. (2015) Beneath a learning management system - understanding the human information interaction in information systems. *Procedia Manufact*. 3, 1946–1952, 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015).

2. Dzandu, M. D., Boateng, H., & Tang, Y. (2014). Knowledge Sharing Idiosyncrasies of University Students in Ghana. In Service Science and Knowledge Innovation: 15th IFIP WG 8.1 International Conference on Informatics and Semiotics in Organisations, ICISO 2014 Proceedings, Shanghai, China, May 23-24, pg 348-357.

3. Minh X. H. Doan, Dzandu, M. D. and & Tang, Y. (2018) *A Conceptual Model of Human Information Interface: a semiotic framework.* (Under review - Computers and Human Behaviour).

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5. Boateng, H., Dzandu, M. D., & Tang, Y. (2016). Knowledge sharing among employees in Ghanaian Industries: The role of transformational leadership style and communal organizational culture. *Business Information Review*, 33 (3), pp. 145-154.

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Chapter 1

Introduction

1.1 Research Background

Data, information and knowledge have been and continue to be the basis of human activities (Karwowski and Ahram 2009; Eppler 2006; Kamata et. al. 2003; Jones et al. 2006). Following the adoption and use of information technology (IT) in human activities, there has been increase in efficiency (Lai & Lee 2007; Ong and Lai 2007), effectiveness (Scholtz 2006; Ong and Lai 2007), and for organisations, increased productivity (Scholtz 2006; Chow and Chan 2008; Uotila & Melkas 2007). The capabilities of information technology (IT) and knowledge management and the value it offers to individuals (Erzetic 2008; Lin 2007; Cordoba & Isabel 2004; Bock et al. 2005; Chang et al. 2008), organisations (Scholtz 2006) and the general society (Mohd & Nor 2012) cannot be overestimated. The uptake of IT in every facet of life has been very phenomenal. However, IT is only a tool and an aid to data, information and knowledge activities. Whilst IT is capable of capturing, storing and processing data based on pre-defined instructions, IT is not capable of automatically converting data into information and knowledge (Bhatt 2001; Kanehisa et al. 2014).

Individuals, organisations, and society rely on information system (IS) of varying complexities and capabilities for personal, business and other functions. IS/IT systems rely on stored data, which when retrieved and processed generate information used to engage in various knowledge activities such as knowledge sharing, transfer, acquisition, storage, among others. However, there has long been concerns about the quality of stored data in IS/IT systems, from which information is generated to support knowledge activities (Matusik & Heeley 2005; Lai & Lee 2007; Beesley & Cooper 2008; Sowe et al. 2008; Lew & Yuen 2014; Lew et al. 2013).

Sources of data quality concerns have been well documented (CIMA 2008; Cai & Zhu 2015) and include among other issues the capture, transfer, pre-processing; as well as the IS/IT system issues such as quality of storage devices and data handling. However, issues about missing context information when storing data in IS/IT systems needs to be given much attention; especially given the importance of context in human activities. Lack of context creates problems for users who have to add their own meaning to data retrieved from the IS/IT systems in order to engage in information and knowledge activities. Thus, whilst IS/IT systems are designed to represent data, they are deficient in creating meaning. The study is approached from two angles, first is the human-IT/IS system challenge of inadequate context in data representation; and then the human-information challenge of creating meaning from context deficient data stored in an IS/IT system.

Building more context into stored data in IS design would in no doubt help individuals, organisations and the society at large to realise the true value of knowledge activities as it will allow for context-specific knowledge activities. Thus, wherever one interacts with stored data in IS, there is a reduction in the reliance on own knowledge of people in an attempt to understand and use the information. The increased context in stored data would also enable organisations to derive more value from big data (Cai & Zhu 2015; Phillips-Wren et al. 2015), data mining, and business intelligence, whilst allowing more intelligent robots (i.e. AI and computer systems) to be programmed.

This research utilises multidisciplinary extant literature from human computer interaction (HCI), information systems (IS) and computing, business informatics, and social theories to establish the statement of the problem. The conceptualisation of the research problem focused on context deficiencies in stored data in information systems (representation) on one side; and information activities (meaning) associated with the retrieval of the data from the IS for knowledge activities. The reviews, therefore, focused on the interactions at the interface between human and data, data and IS, and human and IS; whilst assessing the impact of the larger social environment on knowledge activities using culture as a proxy. The design of interfaces in IS are reviewed to identify the current limitations or challenges of missing context in stored data in IS. Complimented by a series of studies, a conceptual model of human information interface is proposed and refined, i.e. to address the problem identified. An evaluation of the proposed framework to incorporate more contexts into the interface of IS/IT systems is presented and serves as a basis for the conclusions and the proposed future research directions.

The study is limited to knowledge activities, and the aim is to develop an artefact in the form of a framework for improving the quality of knowledge activities. This study does not aim to develop an information system but to contribute to understanding and advancing knowledge concerning the human information interface, which is beyond the purview of human-computer interaction.

1.2 Research Context

Over the last two decades, a lot of attention has been focused on knowledge management primarily because of the shift from the information society to this era of the knowledge economy. Knowledge has been described as a significant resource to individuals, organisations and society. Researchers have explored and reported the significant impact of knowledge acquisition, transfer, sharing and general management to individuals and organisations. It is worth noting that, with the proliferation of technological systems, devices and applications, most knowledge activities are computer-based. This means that most organisational knowledge activities require human interactions with computerised information systems. The relevance of human computer interaction (HCI) in designing user-friendly information systems (Zhan & Li 2004) is therefore critical for effective and efficient knowledge activities.

In most modern organisations, information technology is used as the main working tool. This means that various information systems are required to support the functional activities of organisations including the low level task of data collection, data processing, storage, archiving, and management and high-level activities; including but not limited to data and information analyses, business intelligence, problem solving, decision making, knowledge management, organisational learning, among others (Eppler 2006; Blandford & Attfield 2010). The need to design user-friendly information system has to a considerable extent been addressed by HCI. Several authors have also provided enormous literature on information seeking behaviour, information interaction, storage, processing, and use (Pettigrew et al. 2001; Eppler 2006; Marchionini 2008; Blandford & Attfield 2010) all of which have implications on information system design. However, current information systems are still lacking in key characteristics such as pragmatic and social context.

Human information interface is a discipline that focuses more on the human issues beyond the technical issues in HCI. Whilst HCI has been somewhat successful at physically representing information at the IT platform level in relation to the semiotic ladder, it is still lacking in adequately representing the context of data in computer-based systems in order to enhance the usability of information retrieved from information systems (IS). This is particularly so because of the challenges with delineating data, information and knowledge as well as the complexities involved in understanding the different dimension of information (Marchionini 2010). This means a focus on the human information functions of Stamper’s (1973) semiotic ladder.

Current IS design and socio-technical approaches to IS research focusses more on the design science aspect of IS, with little emphasis on the behavioural components which has to do more with the user than the IS. The question that arises is how do we incorporate human behaviours in IS to ensure that the context of data acquired and stored can match with users intentions? This is because information found in current IS, is still lacking in pragmatic and social context, leaving in its footprints a mismatch in intentions of the creator and the user of information. According to Eppler (2006), the objective of knowledge management is synonymous with information management, which has to do with making data actionable or ensure that stored experiences are reusable. However, how useable is data and information that is lacking in context? How sure are users that the decision they take based on the information they retrieve from computer-based systems are accurate since there is lack of context?

1.3 Research Motivation

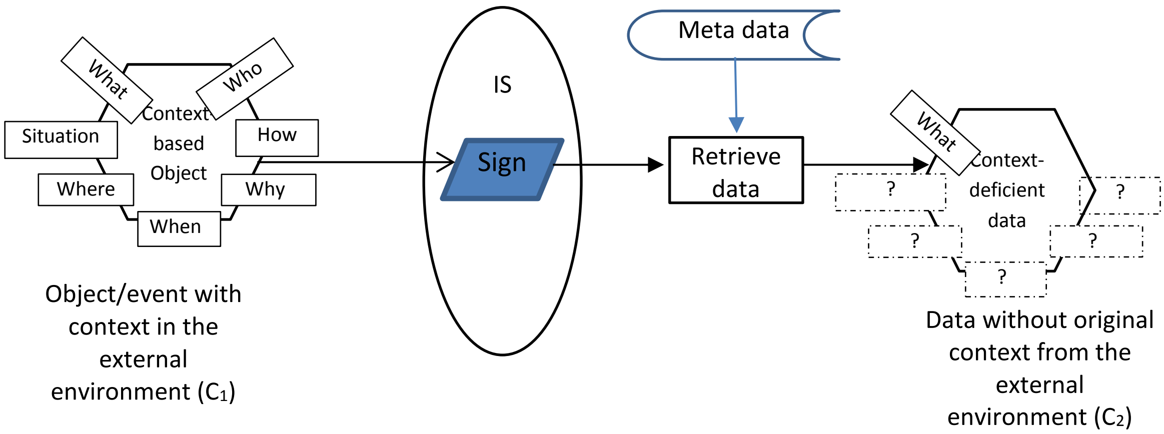
The motivation for this study is to understand the sources of missing context in stored data in IS/IT systems and develop a framework to solve the problem of context deficiency in stored data and information used for knowledge activities. The challenge arose from the researcher's experiences of working as a systems analyst; software developer; and data analysis specialist providing data cleaning, data entry, analysis and interpretation for individuals, small, medium and large-scale organisations as well as international corporations.

1.4 Problem Statement

Considerable proportion of knowledge activities, especially in organisations, including acquisition, sharing, storing, codifying, transfer and use (Lai & Lee 2007; Lew & Yuen 2014; Lew et al. 2013; Heavin & Adam 2012; Morettini et al. 2013) are now mostly done through electronic mediums, and therefore output is dependent on the quality of information systems. However, data or information stored in IT systems is quite often lacking in context.

At the point of storing data into information systems, the context of the data is not stored with it. This problem of missing context carries on through the processing and use of the information for knowledge activities. At the point of retrieval and use of this data, which has been processed into information, users have to apply their own meaning to the information they retrieve from the IT system. The ultimate meaning of the information might not match the original context of the data in the external environment. There is thus a huge gap between the user's pragmatic requirements and the social context within which the information is retrieved for use, and the intentions with which the original data and information were created. In effect, information found in computer-based systems could only be an approximation of the initial intentions of the information creator and users intended use of the information.

Figure 1.1 illustrates the problem of missing context in stored data in IS/IT systems where $C_1 \neq C_2$.



$(C_1 \neq C_2)$

Figure 0.1: The current problem of missing context in stored data

How much context is lost or missing when data transition from collection, through processing and storage, and retrieval for use; and how does this affect information and knowledge activities? What factors affect the quality of the data stored in computer-based information systems and how does it impact on knowledge activities? How can the human-information interaction process be improved to enhance effective and efficient information and knowledge activities?

Information found in computer-based systems should have syntactic, semantic and pragmatic characteristics. However, considering the information life cycle, at the data source is the data interface, where only syntactic representation of data in the information system is possible. Semantic and pragmatic characteristics are thus missing at this stage. At the processing and storage stage, meaning is added to the data as per business rules Opoku-Anokye (2014), norms (Liu 2000) and procedures. However, the information at this stage has only acquired meaning based on the users assumptions which might be different from the original context of the data at the point of storage into the IS/IT systems. Thus, the data and information, at this stage would still be lacking the original pragmatic and social contextualisation.

In order for users of information to create the right knowledge out of information at the point of retrieving it, pragmatic and social contextualisation are needed. Can an information journey, from the data source, through processing and storage and retrieval, have and consistently maintain the same context details to ensure that there is no gap in the intentions of the information creator and user? In the light of these challenges, this study aims to develop a model for understanding how humans interact with information in computer-based systems.

The current interfaces of IS provided by HCI approaches are technically oriented, data driven and at best only capable of syntactic representation of the data or information. Several studies thus provide evidence of the problem of missing context in stored data or information in current IS based on existing HCI interfaces (e.g. Dey 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa 2003; Opoku-Anokye 2014; Dzandu & Tang 2015).

1.5 Research Aim and Objectives

The aim of this research is to investigate how the quality of data and information in computer-based systems impact on the quality of knowledge activities. The specific objectives of this study are to:

1) analyse and identify the sources of missing context and information gaps in stored data and information in information systems,
2) explore the effects of individual culture on data acquisition, information storage and retrieval from computer-based systems,
3) to develop a framework that incorporates user's pragmatic needs and social context into the data interface of computer-based information systems,
4) to evaluate the human information interface framework using case studies to assess how it enhances the usability of information from computer-based systems,
5) to validate the model using case studies to ascertain the extent to which improved data and information interface design impact on knowledge activities.

1.6 Hypothesis and Research Questions

The main research hypothesis for this study is:

Improved data and information system interface design would reduce the problem of missing context in stored information and enhance the quality of knowledge activity.

The main research question is – Why are there misconceptions about the true value of knowledge derived from data stored in IT systems?

The following will be the specific research questions to be answered:

1) What are the sources of missing context and information gaps in stored information in computer-based systems?
2) How does individual culture influence data storage and information retrieval from computer-based systems?
3) How can the designs of information systems effectively incorporate users' pragmatic needs and social context into the data interface?
4) How can pragmatic and social context be built into the information interface to enhance the usability of information retrieved from computerised information systems?

5) To what extent does improved data and information interfaces design impact on the quality of knowledge activity?

1.7 Research Contribution

This research aims to make novel contributions to scholarship in information systems interface design, knowledge management systems, quality issue in IS/IT systems and human information interface.

1.7.1 Theoretical Contribution

This study contributes to information systems design theories, whilst expanding scholarship on human information interaction. The reviews and analyses of the impact of culture on human information interaction would offer possible empirical evidence on how culture impact on information systems and contribute to the debate on why information systems fail, how to design flexible information systems, especially global information systems as in the case of multinational companies. In addition, this study contributes to the advances in the field of human information interface, which seems to be a relatively new discipline in an attempt to focus attention more on human issues that lie beyond the purview of human computer interface (HCI).

The contributions of this study to theory could also be found in the area of socio-technical approach to information systems. The outcome of this study in the form of a human information interface framework contributes new perspectives to the theoretical underpinnings of the data, information, and knowledge evolution and their implications for the quality of information and knowledge activities, knowledge management systems, decision-making, business intelligence and big data.

1.7.2 Methodological Contributions

The study provides several methodological contributions by way of modelling culture as a function of the social environment in the semiotic framework. It adapts Hofstede's cultural dimensions to information systems research and provides new perspectives to data storage and information retrieval from IT systems whilst clarifying the sources of context deficiency in stored data in IT systems. Whilst the semiotic layers include social-environment, most researchers have focused their studies on the syntactic and semantic layers, with less consideration for the pragmatic and the social-environment dimensions. This study seeks to demonstrate that, methodologically, the social-environment can be operationalised and modelled to ascertain the extent to which, it affects knowledge activities (pragmatics).

1.7.3 Practical Contribution

The human-information interface framework developed can serve as a guide in the design of improved data and information interfaces that incorporates the context of data into stored information in computerised information systems. This should help make information found in computer-based systems more adaptable to user's pragmatic requirements and social context.

Currently, there seem to be no framework for information systems design that reflects users' cultural orientation, intentions and usability requirements. The implementation of the HII framework can help address the current challenge of missing context in stored data and information in information systems (IS). The improved interface design should help provide more contexts and enhance the quality of knowledge activities based on stored data/information. This should have enormous potential for improving the capabilities of AI, expert systems; machine learning and computerised information systems.

Furthermore, the study contributes to understanding the data, information and knowledge management for enhancing information management functions in organisations. Given that the study showed significant relationship between individual culture and knowledge activities, information management practitioners would find the results useful especially for personnel management. The adapted cultural scale can be used to assess and establish the competencies and capabilities of data management personnel in order to fit their skills and cultural disposition to appropriate data management job tasks and responsibilities.

1.8 Structure of the Thesis

The thesis is structured in eight chapters, with a summary at the end of each chapter. The first section so far has looked at the introduction and background to the study. Here, explanation of the context of the study and the researcher's personal perspective on the phenomena under investigation are presented culminating in the research motivation and problem statement. The research aims, and objectives are outlined, and the expected theoretical, practical, and methodological contributions of the study are highlighted. The structure of the thesis is outlined, and a recap of the chapter is captured in a brief chapter summary. The details of the remaining seven chapters are as follows.

Literature review for the study is covered in Chapter Two. A critical review of literature and theories that link human, data and information interaction in information systems for knowledge activities are presented. The literature reviewed relates to knowledge management, impact of environment on knowledge activities, culture and information systems, and semiotics theory, which serves as the foundation framework for the study. The last section of this chapter connects the research questions to the semiotic theory and inspired the development of the conceptual model in Chapter Four.

The methodology, which underlies the entire study, is presented in Chapter Three. It covers the research philosophy and methods of literature analysis and case studies, data collection and analysis. The choice of design science approach for the investigation and the justifications for its use will be discussed. The chapter will also describe the various methods that will be used in chapters 4-6 to address the research objectives.

Chapter Four – Developing Context-Based Data Interface. This chapter will present the first artefact in the form of a context-based interface model in line with design science methodology. In this chapter, the interaction between individual culture and interface factors in the context of data stored in information systems will be investigated. Design science research iterations will be applied using both quantitative and qualitative methods with series of studies, to identify and address the issues of missing context in stored data in IT systems. Drawing on concepts from the semiotic framework (Liu 2000), individual culture (Yoo et al. 2001) and the system theory of human behaviour, the interrelationship between individual culture and interface factors and their impact on data stored in IS will be investigated. A conceptual model will be developed and validated to complete the first iteration of the design science iteration.

Chapter Five – Context-based information interface. This chapter will expand on the data interface model developed in chapter 4 using quantitative and qualitative methods. The aim of this chapter is to extend the model from the data interface to information interface to demonstrate how context-based data interface impact on the quality of information retrieved from IS for knowledge activities. The relationship between individual culture, interface factors and information objects will be established and validated leading to a refined conceptual model to complete the second iteration.

Chapter Six – Context-based knowledge interface and the human information interface framework for knowledge activities. This chapter will be the third iteration of the design science process. In this chapter, the conceptual models in chapters 4 and 5 will be extended to the knowledge level to produce an artefact in the form of context-based knowledge interface model. This will involve the use of both quantitative and qualitative methods to establish and validate the relationship between individual culture, interface factors and knowledge (as methods of literature analysis and case studies, data collection and analysis). These then set the foundation for the evaluation of the HII framework in the next chapter.

Chapter Seven will report the evaluation of the main research output. Thus, the human information interaction (HII) framework would be refined and optimised through interviews and survey. The relevance and arguments for the potential application of the HII framework will be presented and case studies and scenario analysis will be used to demonstrate how the framework can be utilised.

Chapter Eight – Discussion and Research Conclusion. This chapter will evaluate and summarise the entire research leading to a conclusion. The research contributions will be critically considered and implications of the results and future research direction will be outlined.
The thesis report is categorised into six main blocks, namely:

1. Research Background and Motivation – the introduction to the research, the context of the study, discussions that provide the background and motivation for the research are presented in chapters one
2. Problem Definition - literature will be reviewed to establish the research gap.
3. Research Methodology – the discussions of the methodology, which underlies the entire study, will be presented
4. Research Outputs – comprises the use of three iterations of the design science process to develop three artefacts in chapters four, five and six leading to the development of the human information interface (HII) framework for knowledge activities.
5. Research Evaluation **-** the main research output will be evaluated to provide proof of concept and demonstrate relevance and potential applicability of the framework.
6. Conclusion - will be discussion and conclusion of the research.

Figure 1.2 shows the phases of the research process with respect to the design science process.

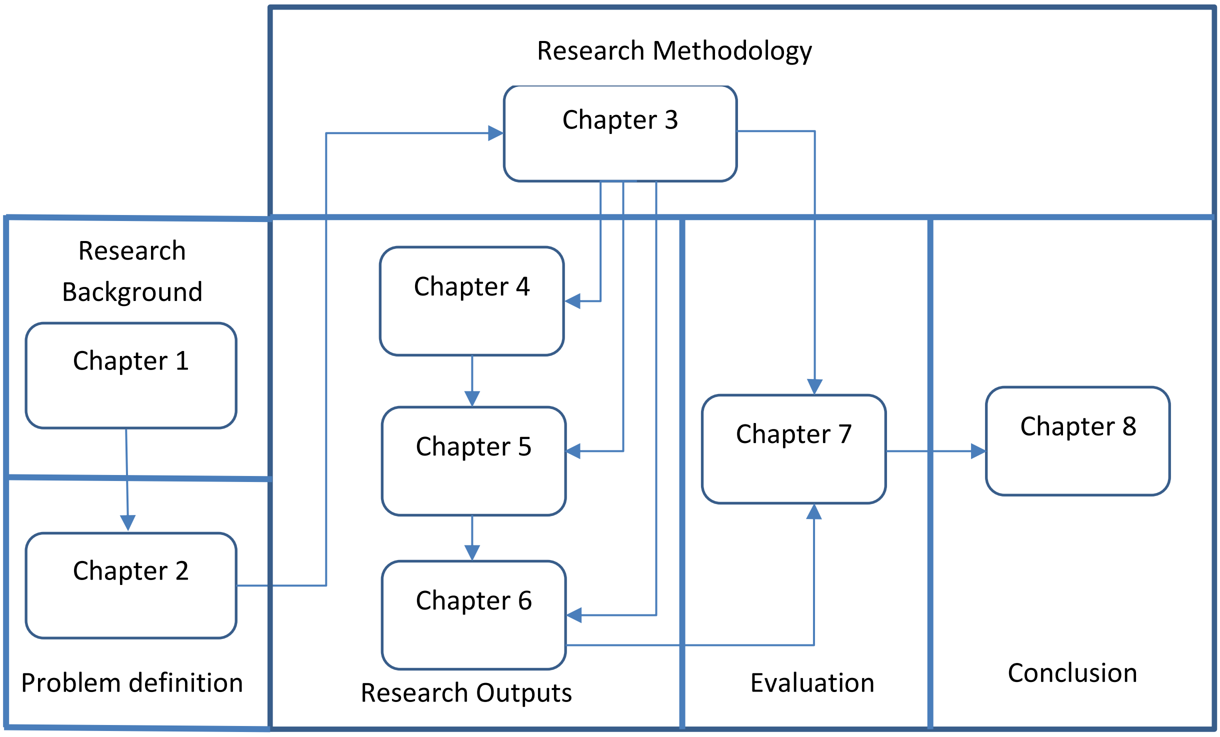


Figure 0.2: Structure of the thesis

1.9 Chapter Summary

This chapter provides an introduction to the entire study by highlighting the research background and context, and the problem statement. The motivation for the study stems from the researcher's experience whilst working as a data analyst and software developer in Ghana and UK. To achieve the aim of investigating how the quality of data and information in computer-based systems impact on the quality of knowledge activities, by building more contexts into data and information interfaces in IS, the research objectives and research questions pursued have been outlined. The theoretical, methodological and practical contributions of the study were provided. The structure of the research is outlined and a summary of the main blocks of the thesis is presented.

Chapter 2
Literature Review

2.1 Introduction

This review begins by defining the human information interface, the challenges of current information systems and developing context-based interfaces in information systems for knowledge activities. It also explores the characterisation of knowledge and knowledge activities, and then focused on the human and environment factors of knowledge management and the interplay. It concludes by exploring models and frameworks for understanding the environment-human factors in knowledge management studies.

A critical review of literature and theories that link human, data, and information interaction in information systems for knowledge activities are presented. The literature reviewed relate to knowledge management, impact of environment on knowledge activities, culture and information systems, and semiotics theory, which served as the foundation framework for the study. The last section of this chapter connects the research questions to the semiotic theory and inspired the development of the conceptual model in Chapter Four.

The literature review is constituted as per the structure in Fig. 2.1. The aim was to establish the necessary theoretical underpinnings, provide evidence of the research problem, and inform the conceptual model for the study.

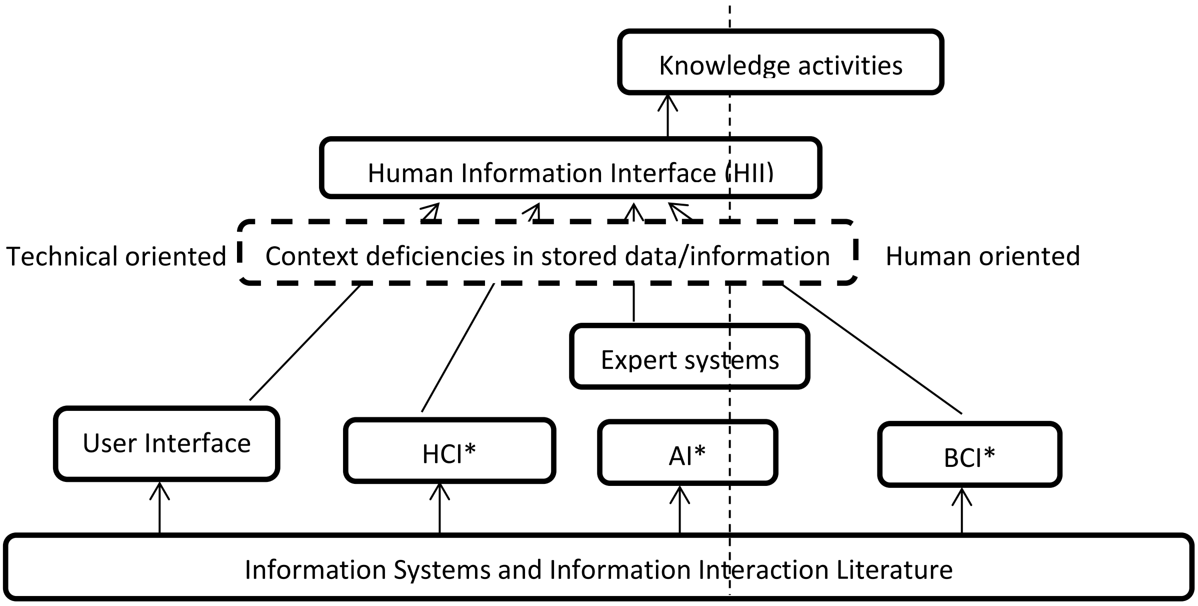


Figure 2.1: Literature Review and Basis of Conceptual Model
*(HCI-Human Computer Interface, AI – Artificial Intelligence, BCI – Brain Computer Interface)

The review establishes the technical and human perspectives of the current challenge of context deficiencies in stored data/information in IS/IT and how these influences the quality of knowledge activities.

The key concepts used in this study are data, information and knowledge (DIK), context and human factors (individual culture). Data can be defined as an abstract of a phenomenon (Daconta et al. 2003). Data has no meaning on its own and does not have value unless it is viewed or interpreted within a particular context (Jessup et al. 2003; Bocij et al. 2003; Groff & Jones 2012). Information on the other hand can be defined as data in context, meaningful or processed data (Seppänen & Virrantaus 2015) whilst knowledge is actionable information. Knowledge is a process of applying framed experience, values, contextual information, and insight to different situations and context to achieve a particular aim. It originates and is applied in the minds of knowers and therefore inseparable from humans (implicit). However, in some instances, knowledge can be embedded in documents, IT systems, databases, or repositories either formally or informally in organisational routines, processes, practices, norms and culture (Davenport & Prusak 2000). Context is defined as any information that can be used to characterise the situation of an entity, object, or event that occurs in an environment or system (Dey 2001). Individual cultural orientation (Yoo et al. 2011) was used as a proxy for human factor or human actor.

For the purpose of this study knowledge - is defined as the links between data or information and previous information or experience in a given situation for the purpose of understanding, and/or deal with a situation. In addition, the definitions of data (Daconta et al. 2003) and information (Seppänen & Virrantaus 2015) will be adopted for the study. The next section looks describes the context of the study, which is human information interface. This is followed by definition of the problem and a discussion of the interaction between human, culture, data storage and information retrieval in IS/IT systems and knowledge activities.

2.2 Towards Human Information Interface

This section of the literature review seeks to introduce the concept of human information and knowledge interface, which looks at the data-information and knowledge debate beyond the scope of human computer interface (HCI). The review begins by identifying the current challenge of missing context when data is stored, and information is retrieved from an information system.

The quest to achieve quality information (Eppler 2006) and knowledge activities (Lew et al. 2013) has attracted and continue to engage the attention of researchers and practitioners. There are still debates on the data-information-knowledge trichotomy (Eppler 2006; Jones et al. 2006; Kamata et al. 2003). The boundary as to where data ends, and information begins; and where information ends, and knowledge begins are still unclear. However, one thing that runs through and remains a challenge is how to ensure quality of data, information and knowledge in information systems (IS).

IS are driven by databases but current databases contain dumb datasets that are not context-aware and inadequate to help users understand and engage in context specific information functions and knowledge activities. Beside friendly IS/IT user interfaces, and availability of database utilities such as data dictionary and meta data, users have had to add their own understanding and apply their own knowledge to data retrieved from IS. The gap between the context deficiencies as the representation of reality through the representation of data, processing of information and application of the knowledge thereof to situations raises concerns about quality.

Data is abstract representation of a phenomenon, meta data is "data about the data" (Daconta et al. 2003; Cai & Zhu 2015), whilst data dictionary is simply the definition of description of the data (Table 2.1). The importance of data and "the shift in power from applications to data" (Daconta et al. 2003) will continue to engage the attention of IS/IT researchers and practitioners. The emergence of the smart data concept is acknowledged but current approaches such as XML, semantic web, resource description framework (RDF), RDF schema, are approaches to integration of data, program and web resources rather than attempts at making data smarter (Daconta et al. 2003). These methods rely very much on the existence of historical data or multiple instances of data and builds on the concept of relational databases to link the multitudes of data for knowledge activities. These approaches thus only offer solutions to poor content aggregation, information overload, stovepipe system among others by providing syntactic interoperability (Daconta et al. 2003). The datasets found in the associated databases remain "dumb" and not "smart" enough. Therefore, the true moment of value of data, which can only be realised by an understanding of the original context of the data at the point of creation, remains a challenge yet to be resolved. These utilities are still unable to provide adequate context for stored data in IS.

Semantic web and XML are attempts to improve the understanding of "data, pages, programs and web resources" through tagging and linked resources (Daconta et al. 2003), yet these advances are still lacking in providing adequate context of data at the point of creation. In addition, XML is simply syntax for semantic web representation and not necessarily a solution to the problem of context deficiencies in stored data in IS.

Table 2.1: Data, Meta data and data dictionary

Data	**Meta data**	**Data dictionary**
Jonny Marks	Name	Name of a person, first name first, followed by surname
42 Whiteknights lane	Address	The physical area or location of the person
Reading	City	The town in which the person resides
RG6 6UD	Post code	The specific location of an addressee/specific delivery point
UK	Country	Country in which the person/addressee is located

Data, Meta data and Data dictionary (adapted from Daconta et al. 2003)

The question therefore is, is it not possible to store enough context about a phenomenon whilst capturing data into IS, so that data will be more meaningful? Is the "data is fact without meaning" not self-imposed by deliberately leaving out the context of the data at the point of storage into IS and giving the power to the user who retrieves the data later on to add context to the data to arrive at information? However, beyond the interface, is the value component of the interaction, which is information. With or without technology/IS, whenever there is an interaction the aim is to be able to achieve some meaningful understanding or undertake some functional activities using information. Therefore, in all instances of interactions, human-data, human-information, and human-knowledge, the most important thing is meaning (semantics) or the value of information. It is argued that data without meaning has no value, and without meaningful information, knowledge activities are either limited, impossible or just based on speculation.

$Data_n$ [x] *x-syntactic representation of data, and n – is the time, n#0*

$Data_n \begin{bmatrix} x \\ y \\ z \end{bmatrix}$ *where x-syntactic, y-semantic, z-pragmatics, and n – is the time, n#0*

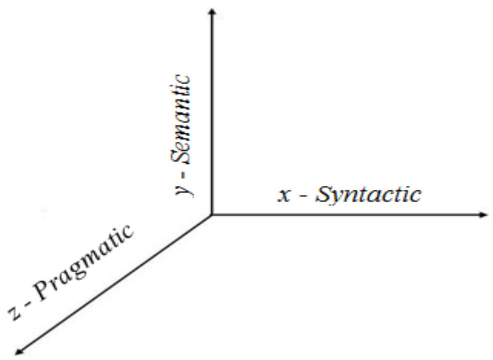


Figure 2.2: Multi-dimensional representation of context-based data/information

It is argued that data/information representation can be achieved as illustrated above at a three-dimensional level as shown in Fig. 2.2. This will allow for more context details to be stored with data during data capture into IS, so that data is retrieved, context specific activities can be undertaken. In effect factual data which will include the "what", "when", "where", "who" and "situation" can be or is implicitly captured and stored as meta-data or "meta-what". This is akin to the present one-dimensional level or the x-syntactic layer. In addition, the "how" and the "why" could be captured and stored in IS/IT system as the "meta-how" and "meta-why" akin to the sematic and z-pragmatic.

The implication of the multi-dimensional storage of data is that context deficiencies between the creator of data and user of information will be reduced, as the user will not have to add his/her own understanding, experience and knowledge to the data to provide a context in order to process the data into information. This will in ultimately enhance the quality of data, information and knowledge activities since an optimal semantic and pragmatic levels will be achieved and help users to engage in real information functions and knowledge activities. The current situation here information is not based on the original context of data but rather than the added understanding of the user will be overcome.

Another possible solution to dealing with the challenge of context deficiencies in stored data in IS, is to have unique identifiers for every data that is stored in an IS (create once), and then cumulate all other characteristics, attributes, and manipulations of the data thereafter. This will first help deal with the problem of data/information redundancies whilst helping build adequate context on the data over a period of time (relational databases & historical data, big data concept, etc.).

$Data_n$ [x_1, x_2, ………… x_n], where n represent the occurrence of a phenomenon over time period n.

Figure 2.3: A plane showing only the x-axis

Graphically this can be depicted as a one by one matrix or a row matrix, which leads to data representation on a single axis and possibly over an n-time frame (Fig. 2.3). However, we posit that data representation can be achieved either as a column vector or as a finite/infinite matrix with the possibility of an empty matrix as shown in Fig. 2.4.

$$\text{Data}_n \begin{bmatrix} x \\ y \\ z \end{bmatrix} \text{ or } \text{Data}_n \begin{bmatrix} x1 \; x2 \; x3 \; x4 & \ldots. & xn \\ y1 \; y2 \; y3 \; y4 & \ldots. & yn \vdots \\ z1 \; z2 \; z3 \; z4 & \ldots. & zn \end{bmatrix}$$

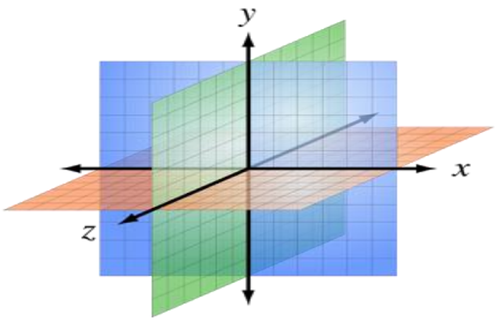


Figure 2.4: x-y-z plane (Stack Exchange Inc, 2015)

The authors posit that if data/information representation can be achieved as illustrated with the column vector analogy, then this will allow for more context to be stored with data into IS so that at the point of retrieval of information from IS, context specific information functionalities can be undertaken, and context specific knowledge activities can then be carried out. It is believed that this will help reduce if not eliminate context deficiencies in stored data in IS and the retrieved information.

Semiotics has inspired several disciplines even though it is origin is in linguistics. The concept helps to understand the science of sense making. Given that it identifies various layers of the sense making process, namely the syntactic, sematic and pragmatics, the study proposes an approach to the design of information systems where data representation could have more context in order to make IS more intelligent and context specific. Whilst the authors acknowledge that there may be several approaches to solving the current challenge of missing context in stored data in information systems, a possible consideration is the data source.

The current system of data representation in information system is one-dimensional i.e. Data [syntactic] and this is inadequate to represent the entirety of a phenomenon. We therefore propose a system of data storage or representation in IS where adequate context cam be fully captured. This is denoted as

Data [(syntactic, sematic and pragmatic) + social environment] +error

Data is the abstract representation of the value of a phenomenon. It shows the "what" (when and where) of the phenomenon but does not show much of the "why" and "how" of the phenomenon. Considering an analogy with semiotics, this translates into data being the syntactic representation of the phenomenon without any representation of the semantic and pragmatic components. We challenge the current definition of data as facts without meaning on this basis and therefore conceive that if data representation can be achieved at a multi-dimensional level instead of the current one-dimensional level, then data can acquire its meaning from its original context. When this happens, the data will reflect the intensions of the creator so that information processed from data would be devoid of the user's own understanding and knowledge.

Therefore, the question is why do we not allow data to derive its meaning from the original context of the phenomenon from which data was abstracted but rather allow data to derive its meaning from users understanding and interpretation of data in a particular context? Why does the user of data have to add his/her own knowledge to stored data at the point of retrieval in order to create information? Therefore, the current system of storing data in IS can be considered as one-dimensional and inadequate in capturing all the necessary context of a phenomenon.

The main premise of this study is the issue of missing context in stored data in IS/IT systems based on a critical evaluation of the information pyramid (Fig. 2.5). Generally, the notion about the information pyramid is that there is a gradual decrease in the quantity and an increase in quality, as data progresses through information to become knowledge. In other words, there is the reduction of data but enrichment in the value of knowledge. We perceive this as the abstraction of data and the reduction of context. In effect, large amount of the context of the phenomenon is sacrificed through the reduction in the volume of data in order to achieve knowledge. Thus, with increasing level of abstraction of data there is a high potential for the loss of the original context of the phenomenon that the data represents.

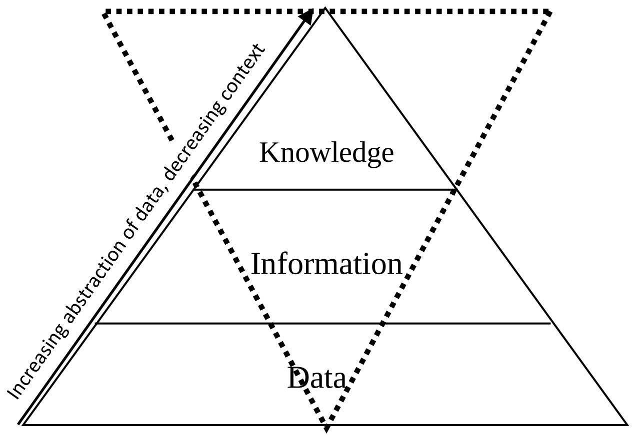


Figure 2.5: Re-conceptualised information pyramid (Eppler 2006; Jones et al. 2006; Kamata et al. 2003)

The problem of missing context becomes even more pronounced if the data has to be stored in an IS, and information created out of the data for knowledge activities. In a situation where the person who collects the data and stores it in an information system is different from the person who retrieves and processes the data into information, for another person to use for knowledge activities, many context deficiencies arise along the way. These raise the question as to how much of context if available when data transitions through information and becomes knowledge.

Over the years, IS designers have consistently aim to improve on the quality of stored data (Eppler 2006) through advances in HCI, interface design (Kamata et al. 2003) and development of advanced technologies. However, the problem of inadequate context of stored data still persist because the current IS interfaces have not been designed to enable the capture of semantic and pragmatic component of data during storage in IS. What HCI does is enabling the syntactic representation of data (Van der Veer & Van Vliet 2001; Daconta et al. 2003), which suggest that the current level of data representation in IS, is at best, only one-dimensional. Nevertheless, beyond the syntactic representation is the need to capture those other components of data in order to improve the sense making and user understanding of information as well as the usability of information for knowledge activities. This seem to have limited the IS interfaces in adequately capturing data at a multi-dimensional level.

Extant literature abounds with studies on human computer interaction (HCI) (Zhang & Li 2004), human information interaction (HII) (Marchionini 2010; Blandford & Attfield 2010; Wilson 1999), human machine interaction (HMI), human-human communication (Reeves et al. 2004) among others. However, to date very limited studies such as Kamata et al. (2003) has contributed literature on the concept of human information interface design; and although they described the concept of human information interface (HII), they focused on how to design information interface based on a multiple regression model. Moreover, although Dzandu and Tang (2015) mention the concept of human information interface (HII), they also did not explicitly define it. Therefore, there is yet no explicit formal definition of the concepts of human information interface (HII) and human knowledge interface (HKI). This review seeks to fill the void in literature by extending the definition of the concept of HII to include HKI.

2.2.1 Challenges of current information systems

IS are representations of reality (Liu 2000), and users could benefit from comprehensive representation of data in IS if adequate context can be stored with the data to reflect the semantic and the pragmatic components of the data. Current interfaces from HCI perspectives and within the semiotic framework, suggest that only syntactic representation of data is possible during data input in IS. An illustration of the current challenge with data storage and information retrieval from an IS, is shown in Fig. 2.6.

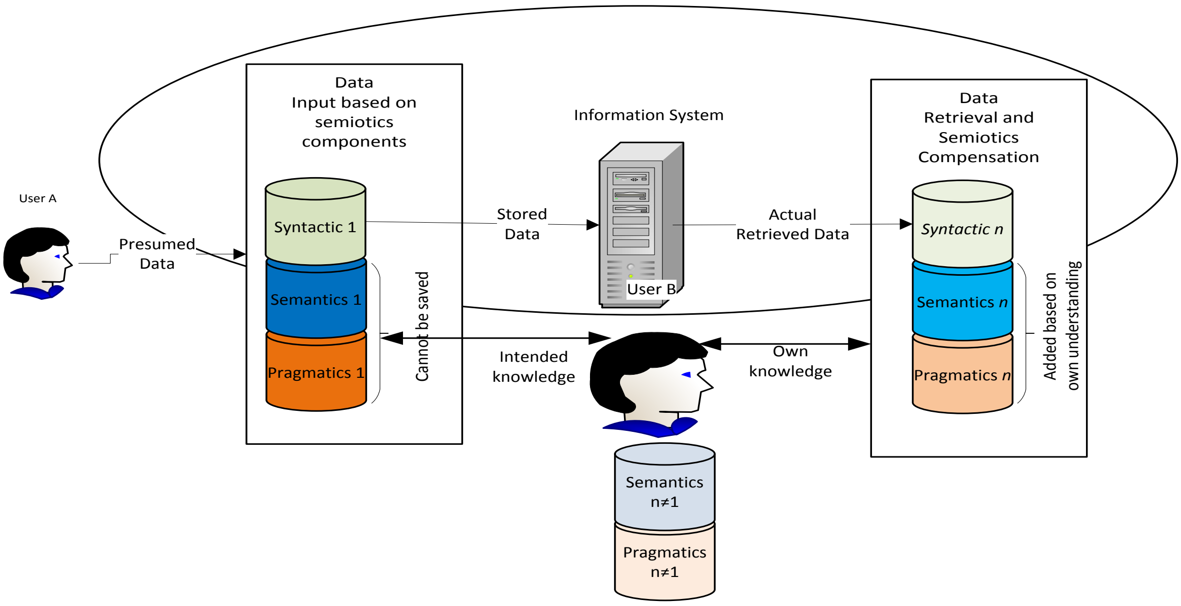


Figure 2.6: The current challenge of missing context in stored data/information

A human actor interacts with information systems in the following two interfaces: one is the interface of inputting data into the information systems and the other is to retrieve useful data from the systems. During the process of saving and retrieving, the human actor usually selects a minimal amount of information, that links to or is associated to the data (either semantically or pragmatically) to be stored in the format of data into the systems with predefined associations. Information, which is created by the human user and carried by the information object, should ideally consist of all the semiotic elements.

In the reversed direction, however, the information system can store and provide information objects, which contain only two elements: syntactic representation and partial semantic content as predefined in the format of another syntactic value. The pragmatic or social aspects depend solely on the human interpretation, i.e. the ability to acquire such information from own knowledge or from any reliable sources. The similarity of semantic 1 and semantic n, similarly the pragmatic 1 and pragmatic n are essential towards the interpretation of retrieved information from systems. The processes of data object being stored and retrieved are illustrated in Fig. 2.6. The factors associated in these two interfaces form the fundamental concept of HII.

The current system of data/information representation/storage in IS, is inadequate to help users to engage in context specific information and knowledge activities. Attempts at improving data/information capture into IS or IT systems has largely been explored within the HCI domain. It is argued that HCI largely relates to the human-machine interaction, i.e. where the aim is to help capture data into IS. It focuses more on the syntactic level of the semiotic ladder by representing a phenomenon in the form of data through user interfaces. In other words, current IS interfaces helps capture only the “what” or the value component of a phenomenon with very little, or no emphasis on “why” and “how” components of stored data/information especially in IS.

For instance, in the design of IS to support organisational and personal use, there is a focus on capturing only parts of the data/information that is deem relevant, as a result only such data/information are stored. At this level, the stored data is one-dimensional, showing only the “what” component of the phenomenon. This means that the “how” and “why” components of the data are left out during data capture leaving the user with the challenge of having to apply his/her own knowledge, experience and understanding to provide a context for the retrieved data in order to create or generate information by add meaning (semantics). This certainly creates and leaves context gaps between the original intentions of the information creator (1) and that of the information user (n), such that n≠1 (Fig. 2.6). This context gap is even made worse when the stored IS data/information has to transferred between different users at different levels.

For example, in a typical organisation, operational staff creates data without providing enough context, management staff generate information mostly based on their own knowledge, experience and understanding which might be different from the and strategic create new knowledge or strategic decisions based on this information. In effect how much of the real context of the data is available at the top level to make for context specific knowledge activities? In other words, the user who creates the data in the IS, might not be the same person to generate information based on the data and might not be the same person to create or undertake knowledge activities based on the information.

A look into existing literature on information quality (Price & Shanks, 2004), data quality (Eppler 2006; Jones et al. 2006; CIMA 2008), knowledge quality, metadata, data dictionary and sematic web (Daconta et al. 2003) highlight inadequacies of current information systems in addressing the deficiency in stored data in terms of lack of semantic and pragmatic representation, which has been described as a failure of current HCI (Jones et al. 2005; Sellen et al. 2009; Marchionini 2010; Anderson 2001).

Knowledge derived from IS/IT systems and used for decision making, planning, sharing, transfer and use might have pragmatic and social context gaps and be missing out on a lot of vital, context specific and relevant details. Therefore, the question is could organisations be making wrong decisions because of the missing context of information when data is being stored into an organisational information system? Are there gaps or context deficiencies in the information stored in organisational information systems because those involved in the data collection (operational staff) are not the same people who processed the data (tactical level staff) and take strategic decisions based on the data and information?

2.2.2 Literature of the Problem - towards context-based Interfaces in IS

The literature of the problem can be traced to several studies (Su et al. 2013; Bauer et al. 2014; Rozado et al. 2015; Music & Murray-Smith 2016; Hollis et al. 2017) on human information interactions (HCI) which among other things have covered different aspect of the discipline. For example, there are studies that focused on human behaviour in HCI (Parés & Altimira 2013; Janssen et al. 2013; Levin et al. 2013; Kim et al. 2016; Su et al. 2013); some that focused on usability issues in HCI (Brock et al. 2015; Music & Murray-Smith 2016; Sundar et al. 2014); and other studies that focused on design issues and how these affect human information interactions (Bauer et al. 2014; Rozado et al. 2015; Rule et al. 2017; Hollis et al. 2017).

In all these, the aim was to achieve data or information representation as well as understanding human behaviour and user satisfaction with HCI interfaces. There seem to be less emphasis on the context of the data stored through the HCI interfaces into IS/IT systems. HCI studies that have looked into context focused more on visual aids (Rule et al. 2017; Hollis et al. 2017), geo-location (Bauer et al. 2014; Hayes & Truong 2013; Shklovski et al. 2014) within context-aware systems literature. However, in all these cases the data generated is stored in information systems with databases serving as the backbone. There is therefore the need to understand context of data issues in IS/IT systems.

After representing data through signs in IS, there is the need to retrieve and engage with the data to make meaning (semantics); and utilize (pragmatics) it to achieve a purpose through various information and knowledge activities. Given that the stored data lacks adequate context, it suffices to say that information and knowledge activities undertaken based on the stored data, which is deficient in context, would be largely based on assumed "context" which might not match the original context of the data. Therefore, can more context be built into the data and information interfaces in IS/IT?

Context have been defined and conceptualised in different ways, settings and situations to denote the same thing the environment within which an event happens. However, for the purpose of this study, context of data is conceptualised as user identity (who), object identity (what), location (where), time (when), user intention (why) and user gesture (how) (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007), and situation (Sowa 2003) under which the event occurred. Data therefore exudes all these context variables. However, in storing data in IS, only the sign about the data (i.e. the what) is capable of being stored, largely because the current state of databases and

IS/IT interfaces only allows users to capture the sign and not those other details. So, whilst the syntactic function is achieved, those of semantic and pragmatic are not or at best based on assumed context, which might not be accurate. It is also asserted that most of the context issues are more human-oriented rather than technical, therefore requiring a paradigm shift from the current HCI to HII in order to advance scholarship in HCI, which seem to have stagnated in the past decade.

In an attempt to extend HCI studies beyond the current discourse to human information interface (HII), Kamata et al. (2003) looked into human information interaction as an approach to the design of information interface. However, he fell short of explicitly defining HII, and rather focused on identifying the components and measures for quality information interface using multiple regression.

Also, although Dzandu & Tang (2015) mentioned HII the concept of HII was not defined and their focus was more on identifying the challenges that learners face in understanding the content of the eLearning course (which was used as a proxy for IS). Their study found evidence of missing context in the stored information (eLearning content) which affected the learners' ability to engage with the content and successfully formed new knowledge. The source of the problem was traced to lack of context as the content of the eLearning materials transitioned from the content writer, through the content developer, the testers and the facilitators' and ultimately to the leaner (McCarthy & Wright 2017).

The questions that arises is could the context of the contents have been stored with it at the source (from the content writer) and consistently made available to each of these users anytime they interacted with the eLearning materials? It is acknowledged that whilst current HCI provides solution to the problem of syntactic representation of data/information; it only fulfils its core function of helping to capture data/information into IS/IT systems. Both the interfaces provided by HCI and the databases that support the storage of the data/information are unimodal and unidimensional and therefore do not support multimodal data representation which will allow for those other context information (why, where, how, when, situation) about the data to be captured at the first point of capture. The context of data problem at the syntactic level therefore remains unresolved.

Also, although Opoku-Anokye (2014) proposed a solution to semantic gaps in IS, this was specific for business data for BI activities. His proposed solution only solves part of the problem of missing context in business data and not for context of data which could potentially enhance the quality of information activities when data is retrieved from IS/IT systems. Additionally, Opoku-Anokye (2014) emphasised that the pragmatic gaps (from lack of context) between information object and human user remains unresolved. However, with the proposed context of data solution, human users can engage in context-specific knowledge activities (pragmatic) when they retrieve stored data and information from IS/IT systems.

From the evidence of problem and in identifying the sources of missing context in stored data/information in IS/IT systems, the evidence suggests the critical role of the human actor, IS and the environment which includes culture, rules, norms. However, the human actor is a function of environment and epitome of culture. The human actor, with semiotic capabilities, is the one who perceives an object, event or phenomenon in the environment through some reductionist principle (Gibson 1978) and tries to represent this as a sign in an IS/IT system, which in itself is constrained by systems limitations. This therefore results in insufficient context details of an object, event or phenomenon being stored in the IS/IT system. The next sections briefly discuss the inter-relationships between these elements as well as the operational definitions of key concepts.

2.2.3 Human factors, Culture, and IS

Interaction is influenced by cultural and social factors, personal characteristics, and context (Schmidt 2000; Dey 2001; Gibbs et al. 2003; Alhammad & Gulliver 2013; Ajmal & Helo 2015; Alhammad 2015). In this section, the inter-relationships between key concepts such as people, data/information, knowledge, context and knowledge activities, through the lens of semiotics, are highlighted. The purpose is to provide a view of how the key constructs namely data/information, people and context links up with knowledge activities (Fig. 2.7).

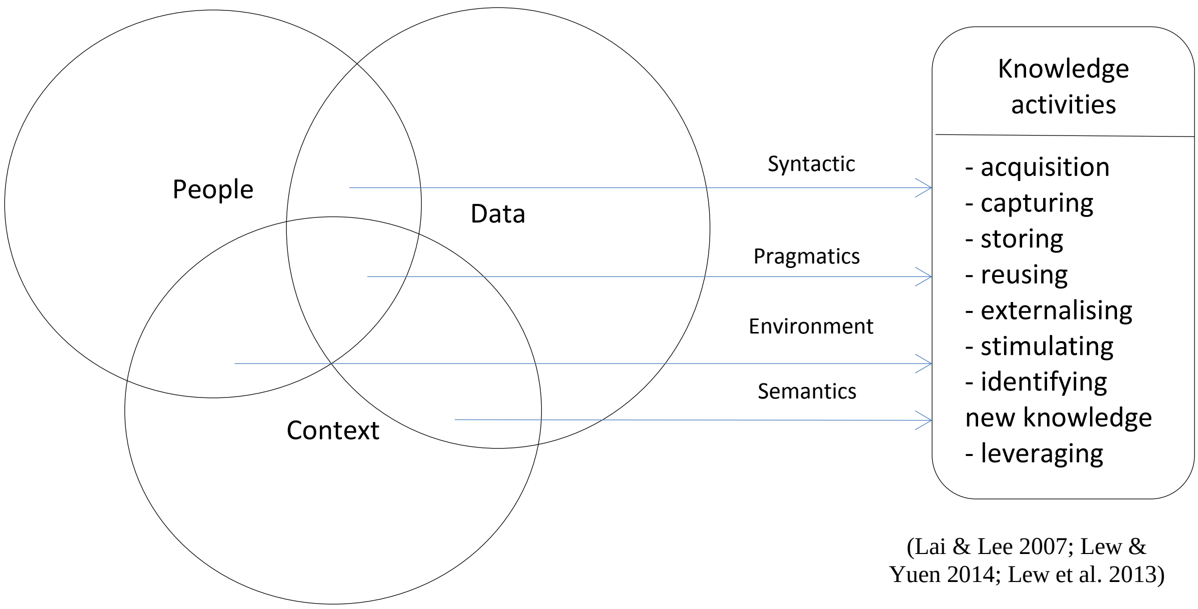


Figure 2.5: Human-data-context interactions for knowledge activities

Data – people interaction: this is conceived to represents the syntactic aspect of the knowledge activities, which is one of the key aspects of the study. The dimensions of this constructs included quality, quantity and frequency of data. Knowledge activities could be riddled with irrelevant, inaccurate, and unreliable pile of low quality knowledge arising from poor quality data as a result of inadequate context, making knowledge utilisation time-consuming, unproductive, and a disincentive to users to engage in knowledge activities (Lai & Lee 2007).

People – context interaction: The environment denotes this and it relates to issues that border on the context of knowledge activities. It includes dimensions such as tools (IT), and culture/norms. The need for the consideration and the importance of culture in knowledge activities has widely been professed (Davenport & Prusak 1998; Bhatt 2001; Lai & Lee 2007). Also, although technology is very much an enabler of knowledge activities and a critical facilitator of knowledge management, it is considered a poor substitute for converting information into knowledge (Bhatt 2001).

Data-context interaction: this is characterised by the semantics aspect of the knowledge activities. The dimensions include rules, policy, procedures, and methods. How much context is captured when data is stored – how complete and of what quality is the data used, i.e. as a basis for extracting information for creating new knowledge?

People-data-context interaction: this is conceived as representing the pragmatics aspect of knowledge activities. How much context is available when people interact with data in order that their knowledge activities are pragmatic enough?

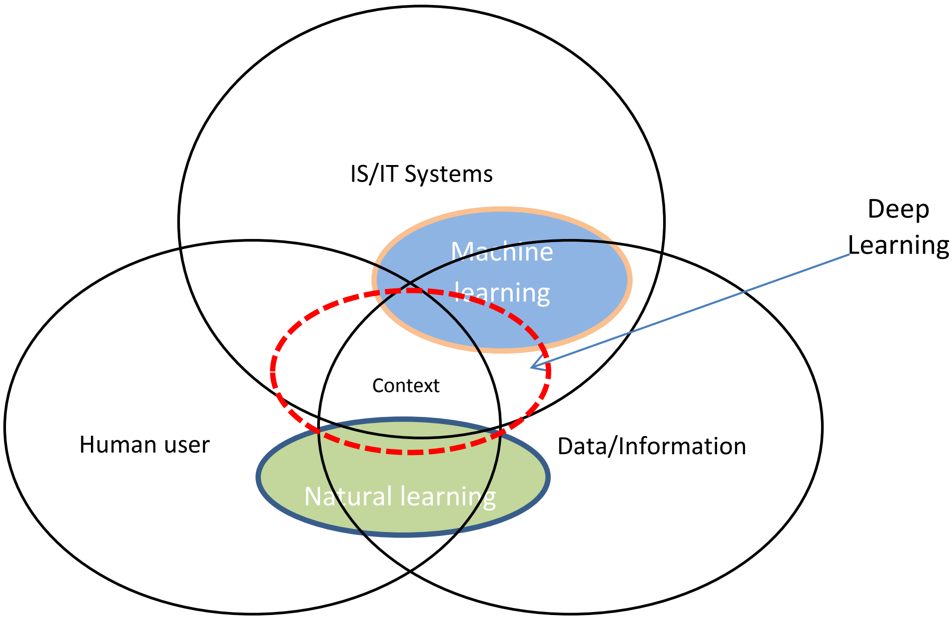


Figure 2.6: Learning models in Man-Machine Interface

The importance of context in the drive to archive deep learning is emphasised in the conceptualised learning model in man-machine interface (Fig. 2.8). From the model, it can be inferred that humans will learn naturally by simply interacting with data/information within a certain context. The human user can apply his/her cognitive, perceptible and experience to action data into information and action information into knowledge. Thus, organic learning can take place without IS/IT systems. However, machine and deep learning can only occur when stored data or information has been pre-programmed. Therefore, the availability of considerable context details especially the "why" and "how" about an event or object has the potential to enhance machine and deep learning capabilities.

2.3 Information, Culture and Knowledge Activities

Information processing and subsequent behaviour, activities or actions taken are influenced by several factors including culture (Lai & Lee 2007; Borodistsky 2001), social, and personal dimensions (Schmidt 2000; Crawford 2003; Gibbs et al. 2003; Alhammad & Gulliver 2013). The likely effects of human factors in creating misunderstandings during information assimilation and processing, and the formation of negative attitude and the impact of these on actions, behaviour and activities are noted (Borodistsky 2001; Alhammad & Gulliver 2013). Personality and psychological state (Crawford 2003), affect human interaction and behaviour (Oinas-Kukkonen & Harjumaa 2009; Kotler & Armstrong 2004). For example, how people interact, and process information is influenced by their cognition, culture and personality (Borodistsky 2001; Alhammad & Gulliver 2013).

Culture can serve as a powerful frame of reference for thinking and actions (Lai & Lee 2007). This study is rooted in the assumption that "culture is communication" (Hall & Hall 1990) hence people from different culture will assimilate and process the same information differently often shaped by their differing cultural norms, values, beliefs, language, etc. (Hofstede et al. 2010; Hall & Hall 1990; Alhammad & Gulliver 2013; Borodistsky 2001).

Culture influences communication (Hofstede et al. 2010) including how people process information and what they do with it after they have processed it. For example, in low context (LC) cultures there is emphasis on the information in the message (Hall 1990; Hofstede et al. 2005; Traindis et al. 1988), whilst people in high-context (HC) societies turn to focus on the context of the information (Hall 1990, Biswas et al. 1992, Lin 1993). Also, trust in a system is influenced by information quality, quantity of the system as well as information processing ability (Teo et al. 2008; Butler 1999).

Culture is a way of live or behaviour of the members of a group (Hofstede et al. 2005). It plays a very important role in attitude, behaviour and knowledge formation (Trompenaars & Hampden-Turner 1998). Culture could be explicit (e.g. food, language, etc.) or implicit, where it becomes a manifestation of the personality of the individual (i.e. biological assumptions about existence or ideas about organising life and people) or collectively as a larger society expressed as norms and values expoused by a group of people (Hofstede et al. 2005; Trompenaars & Hampden-Turner 1998; Alhammad & Gulliver 2013). Naturally, cultural distances exist between individuals (Alhammad & Gulliver 2013) and societies (Hofstede et al. 2005; Hall 1990). How people assimilate and process information for knowledge activities is influenced by their culture or the environment in which they find themselves (Bathelt et al. 2004).

Knowledge activity such as knowledge creation and sharing, among others is also a function of location or proximity, environment and context (Costa et al. 2017; Cusumano et al. 2008; Buntain & Golbeck, 2015; Dzandu et al. 2014; Bathelt et al. 2004;). In effect, culture and information processing abilities may affect knowledge activities.

2.4 From HCI to HII – The Journey Towards Human-Centred Interface

The challenge of how people seek, interact with, and use information has attracted the attention of many researchers (Blandford & Attfield 2010; Marchionini 2008; Pettigrew et al. 2001; Wilson 1999). An important consequence of understanding such interaction is to design information systems which support high-level activities such as problem solving, decision making, analysis and learning (Blandford & Attfield 2010). Traditionally, the interactive process between human users and information systems has been considered as information exchange (Marchionini 2008; Storrs 1989; Toms 2002), which helps to perform particular information tasks (Lewis & Rieman 1994; Raskin 2000; Storrs 1989). Information system (IS) interface is the main channel of communication through which data, the physical carrier of information, can be transferred between the participating entities of the interaction. Thus, designing user-friendly IS interface is an important consideration in human-computer interaction (HCI) discipline (Zhang & Li 2004).

The development of technology brings the new trend of 'disappearing computer' (Streitz & Nixon 2005) and raises challenges of designing interface as well as examining the ways of exchanging information. Yet, the scope of traditional approaches in HCI is considerably narrow to explore complex issues beyond a perceptible interface (Jones et al. 2006; Morville 2005; Sellen et al. 2009). Further, the nature of human-information interaction seems to be difficult to examine due to the multi-faceted characteristics of information (Marchionini 2010). It is also perceived that the challenge of clearly delimiting the boundaries of the data, information and knowledge concepts makes it even more complex in understanding the information interactions.

The need to achieve context specific semantics and build pragmatics into stored information is beyond the scope of current IS design and HCI research. Whilst HCI seem adequate in achieving a good balance between data collection and information storage in IS at least at the syntactic and semantic levels, it is deficient in adequately representing information to achieve a near or perfect meaning and purposeful use of information at the pragmatic level. The need to address the pragmatic gap in information interaction processes lies beyond the purview of HCI. In the opinion of the researchers, human information interface (HII) may offer a better approach to understanding the data, information and knowledge processes during a human-information encounter by focusing more on the human functions (Liu 2000).

Based on evidence from extant literature on HCI, in this review, attention is on the semiotic perspective, from which information is viewed as a sign, to investigate the implicit aspects that lie at the interface of the human information interaction space and propose a model of human information interface (HII). The next section sets the background for the study by reviewing literature on channels of communication and semiotic models of information systems (IS) and information quality. This is followed by a discussion on refining the information interaction components and then a modelling of the human information interaction interface. The paper ends with discussion and implications of the proposed HII model; and a conclusion on the relevance of the model for IS design research and practice.

Humans interface with information in several ways, forms and instances. However, in most cases some form of media is used. For example, humans interface with information through mass media – newspapers, radio stations, television stations, etc. On daily basis, humans interface with information through IS/IT systems such as Apps, information systems and software on both fixed IT systems and installation (ATM, Desktop computers, pay points and access terminals etc.) and portable mobile devices.

Human information interface has become even more pervasive considering the use of mobile devices for individual activities, business operations and social engagement. Considering the ever-increasing uptake and use of mobile devices, mobile Apps, tracking devices, cloud applications, systems and platforms for social, business and personal activities, human interface with information is unending. The question therefore is what lies in the interface between the human user and information object? A conceptualisation of the domain of this study is shown in Fig. 2.9.

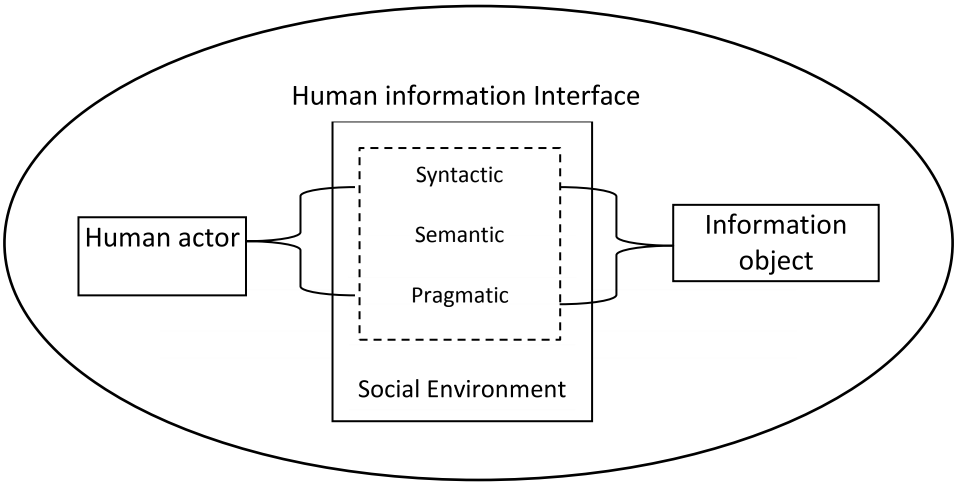


Figure 2.7: Human information interface (with or without IS/IT system)

The purpose of this section of the literature review therefore is to identify the entities that lie in the human-information interface and explore the implications of these entities in human information and human computer-interaction using the semiotic framework as a guide.

The approach of decomposition of objects and actions seems to be convenient for analysing and designing interactive systems. However, the components and the relationships between the levels have not been adequately covered in literature. This dispersion of components as identified in existing literature (Green 1986; Kamata et al. 2003; Storrs 1989) have so far failed to apply a comprehensive model in examining human interaction with information. There are still challenges with pragmatic gaps especially when one considers information retrieved from a system and tries to match its meaning to its source. Mapping from the real world (syntactic-semantic-pragmatic) does not seem to exude the same meaning as the real world (pragmatic-semantic-syntactic), especially when one considers the social environment (Liu 2000).

The understanding of human information interface has great potential impact on the design of interactive information systems (Kamata et al. 2003). Information systems, in general, have been developed purposely to support only syntactic representation and semantic functionality (Van der Veer & Van Vliet 2001). A human actor interacts with an information system and an information object carried by the system through two interfaces: a physical interface to control the physical system, and an information interface to give access to the information object. Information, which is created by the human user and carried by the information object, might consist of all the semiotic elements. For example, a description of online banking procedures (semantic and pragmatic elements) of a bank (social environment) can be edited and saved in the form of an electronic document (syntactic element).

In the reversed direction, however, the information system can store and provide information objects, which contain only two elements: syntactic representation and a fraction of semantic content. Even in this example, more semantic information related to the online banking procedure such as the language used, formats, etc., which would provide more context, would be helpful if users are to understand the information and engage in context informed information activities. The pragmatic and social aspects depend solely on the human side, i.e. the ability to acquire such information, or the recognition of possible impacts. Challenges of information system development are therefore not limited to the designing of physical interface or issues of retrieving and filtering data and information from the information system but should also refer to the system's adaptability to the user's pragmatic requirements and the social environment.

2.4.1 Information system, communication channels and interface design

The link between IS and human actor is ably facilitated by an interface. This interface provides the communication channel for the human actor-IS interactions. The interface therefore serves as the physical link for the human-system interactions particularly at the syntactic and semantic levels of the semiotic layers. Computer interface provides a set of communication channels, through which data is transformed into information in different dimensions. A number of studies have examined these communicative channels and their components with the attempts to develop proper methods for designing system or device interfaces (Green 1986; Kamata et al. 2003; Storrs 1989). For example, whilst Green (1986) in his Seeheim model identified the dialogue and presentation semiotic layers, (Storrs 1989, 1994) came up with a model that identified physical, syntactic, and semantic layers, and Kamata et al. (2003) proposed the semantic, operational and media layers from their study.

Shneiderman & Plaisant (2010) provides one of the most comprehensive models of user interface by identifying four levels. Their model identifies the conceptual or pragmatic level, which is a mental model of the interactive system; the semantic level, where meanings of actions are described; the syntactic level, where the sequences of the actions are defined; and finally, the lexical level, where device dependencies and the precise mechanisms of the actions are specified for the system performance.

These levels of interaction identified in interface-design models from HCI literature, compared and synthesised with semiotic layers, are adopted as the foundation for modelling the human information interface proposed in this paper. A critical look at the HCI models of the channels of communication in the computer-information interface literature clearly shows an expansion in the number of semiotic layers considered by the various authors. From the initial 2 semiotic layers identified by Green (1986) in the Seeheim model, Storrs (1989) and Kamata et al. (2003) came up with 3 semiotic layers. In addition, Shneiderman & Plaisant (2010) expanded the semiotic layers to four in an attempt to provide a more comprehensive model of user interface design. However, there is still a gap in literature on what is HII, and the factors that lie at the interface between the human user and the information object? These are the motivation for this section of the literature review. HII has implications for the design of interactive systems and efforts enhance the intelligence of computer systems.

It is acknowledged that communication channels provide the medium for the data-information and knowledge interaction in a typical information system from literature on HCI. Existing literature offers evidence of the explicit application of the semiotic layers in understanding the data-information communication process. The question is with or without a physical interface as in HCI, how does the human actor interact with an information object (Jones et al. 2006)? On the human actor side, how do we improve the human knowledge of information? In addition, how do we adopt the information object to the human actor's pragmatic requirements within particular social environments (Marchionini 2004)?

2.4.2 Semiotic models of IS and information quality

Semiotics concerns with signs and signifying practices involved in the communication process (Chandler 2000). The interpretation of the sign can be seen as levels corresponding to three traditional branches: syntactic, semantics, and pragmatics, which concern respectively the structures, meanings and usage of the sign (Chandler 2000; Liu 2000). Stamper (1973) and Liu (2000) introduces other three layers in his organisational semiotic framework: physical (e.g. physical properties of the sign representation), empiric (e.g. statistical properties of the sign representation) and social (e.g. social consequences of sign interpretation). Semiotics has been successfully adopted into the development of applicable methods in information system design (Andersen 1997; Liu 2000; Stamper 1993), as well as principles and methods of designing user interface (Connolly & Phillips 2002; Hawizy et al. 2006; Sjöström & Goldkuhl 2004).

The construction of the emerging HII model is based on the semiotic framework of IS features developed by Barron et al. (1999) and the model of information quality developed by Price & Shanks (2004). The purpose of Barron et al.'s framework is to analyse the interaction between an information system and its users. Ten features of the human-computer relation are identified and categorised into four major semiotic branches. Focusing on the information quality assessment, Price & Shanks (2004) categorise information quality criteria into three classical semiotic dimensions. Sixteen quality criteria are identified, including one syntactic, five semantic, and ten pragmatics. Table 2.2 summarises the semiotic levels and their corresponding components discussed in these two studies.

Table 2.2: Semiotic categories and components identified by Barron et al & Price & Shanks

Semiotic layers	IS features (Barron et al., 1999)	Information quality criteria (Price & Shanks 2004)
Social level	Application domain; Action complexity; Social consequence (Barron et al. 1999)	(n/a)
Pragmatics	Acquisition complexity; Acquisition scope; Justification; Input usability; Output usability (Barron et al. 1999)	Perceived rule conformance; Perceived reliability; Perceived completeness based on data use; Understandable; Accessible; Secure; Flexibility presented; Suitably presented; Relevant; Valuable (Price & Shanks, 2004)
Semantics	Real world relationship (Barron et al. 1999)	Complete; Unambiguous; Correct; Non-redundant, Meaningful (Price & Shanks 2004)
Syntactic	Representation (Barron et al. 1999)	Conforming to specific rules, i.e. metadata (Price & Shanks 2004)

Although the two frameworks above are built for different purposes, they show a great applicability to examining the relation between users and information. Both frameworks identify a series of important aspects that appear to be related to the factors identified in information science (Blandford & Attfield 2010; Pettigrew et al. 2001). This set of information quality criteria also forms a guideline for evaluating the quality of the information interaction process. However, the features identified in these works are insufficient to explain other aspects of the interaction, such as the representation of the social effect.

The next section looks at refining the information interaction components by considering the communication view of information interaction, interaction context, human intention and acquisition, information usability, mapping to the real world, and representing the interaction.

2.4.3 Communication view of information interaction

Human information interface is perceived as an information-exchange medium between interactive participants. In this case, an information object is viewed as an information-carrying medium, i.e. sign vehicle (Andersen 1997; Liu 2000). It is worth noting that the participants of the interaction are not only human actors but also computing devices, although computers may not be as meaningful interpreters as human beings (Liu 2000). The key components in a HII, that is at the point where the human actor interacts with the information object, includes the interaction context, human intentions and information acquisition and usability, information mapping and representation.

Interaction context refers to the environment or domain in which the interaction happened. Information interaction can be examined by two types of attribute: contextual and situational (Byström & Hansen 2005). Contextual attributes are stable over a long period of time and create a similarity in information behaviours within a group of people, for example organisational characteristics or the nature of work tasks. Situational attributes are temporal, and may be further divided into different sub-categories, such as individual-related attributes (i.e. knowledge, experience, and ambition), resource-related (i.e. information sources available), and source-specific attributes (i.e. interaction techniques).

A pragmatic information interaction is characterised by three distinct elements namely human intention, information acquisition and information usability. Human intention is identified as an additional component to the set of pragmatic features in Barron et al.'s framework (1999). It is defined as the expectation of the human user involved in the information interaction. The human motivation of interacting with information comes not only from the requirement for conducting particular tasks (Blandford & Attfield 2010; Wilson 1999), but also from non-task-based activities. Hence, the intention covers the information need discussed in information science literature (Blandford & Attfield 2010), as well as the user's intention when communicating with an information system (Hawizy et al. 2006).

After identifying the intention, it is necessary to understand how the human user can obtain suitable information and make it available for an appropriate activity. Thus, the component of acquisition concerns the nature of discovering and capturing information suitable for the usage of the human user. According to Barron et al. (1999), acquisition initially consists of two attributes: complexity and scope. An analysis of the literature of knowledge acquisition suggests 'method' as the third attribute for consideration. In our model, these three attributes are refined as follows:

i. Acquisition complexity refers to the degree of skill, knowledge, and training needed for the human user to be able to discover, understand, evaluate and use the information,
ii. Acquisition scope refers to the range of information sources needed in addition to the interacting information object in order to form a practical usage. The scope includes the internal knowledge of the user and external sources, which can vary from an individual person or information system, or group of multiple sources (i.e. workgroups or intranet), or multiple heterogeneous sources (i.e. inter-organisational sources or the Internet),
iii. Acquisition method refers to the process through which information is being acquired, such as transaction, communication, cooperation, imitation, or appropriation (Kraaijenbrink & Wijnhoven 2006).

Information usability is concerned with the extent to which information can be used to achieve the specific goal of the human user. This component is adapted from the same research theme in the studies of designing information system and software (Abran et al. 2003; Bevan 2001; Scholtz 2006). The three common measures of information system usability identified from literature include effectiveness, efficiency, and satisfaction. Effectiveness relates to the degree of impact of the interaction on the usage of the system or software (i.e. the percentage of a task that can be finished); efficiency refers to the user's effort in using the system or software (i.e. time to finish a task); and satisfaction can be measured by the user's response to the system or software being interacted with. However, most satisfaction instruments are based on the user's attitude towards effectiveness and efficiency (Ong & Lai 2007). Effectiveness and efficiency are also related to the concept of utility, which concerns not only how the information system can be useful but also how it can impact the user's work (Scholtz 2006). Based on the pragmatic criteria set of information quality (Price & Shanks 2004) and other measures of usability (Abran et al. 2003; Scholtz 2006), it can be concluded that information usability can be sufficiently measured by effectiveness and efficiency.

In human communication, semantic mapping stands for the meaning of a message exchanged between participants. These participants can understand each other only if they can facilitate similar interpretations of that message (Liu 2000). In the case of human information interaction, the meaning of information can be interpreted by the human user; but it is nearly impossible for an information object to interpret the human user’s mapping. Thus, the communication channel between human user and information object about the mapping can be examined by two different components on two sides of the interaction, that is, the level of interpretation of the human user, and the quality of the mapping of the information.

There are many ways for a human individual to map the meaning of information to real-world phenomena. For example, the meaning of a word or a sentence can be understood according to at least seven types of semantic mapping (Leech 1981). However, these types of mapping can be generalised into three levels of interpretation: objectivist, constructivist, and mentalistic (Barron et al. 1999; Stamper 1996). Objectivist interpretation is stable mapping, for which understanding is well established with all the people in a community. Constructivist interpretation is negotiable mapping, for which understanding can be established following discussion, negotiation and reconciliation between people. Mentalistic interpretation is the predefined mapping of an individual, for which the understanding is expected to be accepted by other people. Obviously, if a mentalistic interpretation is accepted by other individuals through a negotiation process, it would become a constructivist interpretation; then whenever such a mapping is widely accepted in the community; it would be an objectivist interpretation.

To ensure the acceptance of mapping, the correspondence between information and real-world phenomena must be strengthened. According to Price & Shanks (2004), the semantic mapping between an external phenomenon and internal meaning of information can be optimised through a set of information quality criteria, including complete, unambiguous, correct, non-redundant and meaningful. Price & Shanks (2004) avers that the minimum semantic requirement of information quality is to contain the first three criteria, i.e. complete, unambiguous and correct; and optimal one-to-one mapping occurs when all these five criteria are fulfilled. It can be said that the more criteria that are satisfied, the higher the quality of information, and also the higher the possibility of understanding. However, the quality of mapping might not guarantee that mentalistic mapping becomes a constructivist or an objectivist mapping; unless such mapping is agreed, accepted, and believed by other people. Thus, both components of semantic mapping are related to each other. It is worth noting that the mapping is uncertain: it is changeable. However, as long as meaning can be expressed as a mapping, then it can be analysed and evaluated according to the two semantic components. Basically, there are two types of information-exchange mapping, including creator – information – user and user – information – user. These mappings can be one-to-one, one-to-many, many-to-one, or many-to-many (Sjöström & Goldkuhl 2004).

In information science, information interaction has been represented as a series of human behaviours. The common forms of interaction are purposive seeking and searching of information for a particular task (Blandford & Attfield 2010; Pettigrew et al. 2001; Wilson 1999). However, Marchionini (2008) suggests that both the human and information entities of the interaction should be examined. In line with this, we assume that representation of information interaction consists of three components namely characteristics of the interaction, human interaction behaviours, and characteristics of the information object.

Based on our assumption, a set of representation components are defined based on the faceted model of information interaction classification (Cool & Belkin 2002; Huvila 2010). This model was originally developed as a scheme to categorise aspects of information-seeking behaviours including communication behaviour, interaction behaviour, interaction object, interaction dimensions, and interaction criteria (Cool & Belkin 2002). Practically, it seems to be flexible since it could be amended according to the scope and purpose of different studies and in other contexts rather than in information seeking (Huvila 2010) only.

2.4.4 Components of the Human Information Interface

The HII model consists of four semiotic elements namely syntactic, semantic and pragmatic, and social environment, as illustrated in Figure 2.10. In this figure, the term 'human actor' replaces 'human user', because a person involved in information interaction may be not only a user but also an information creator (Fidel & Pejtersen 2004). The elements and their aspects are discussed in the following text.

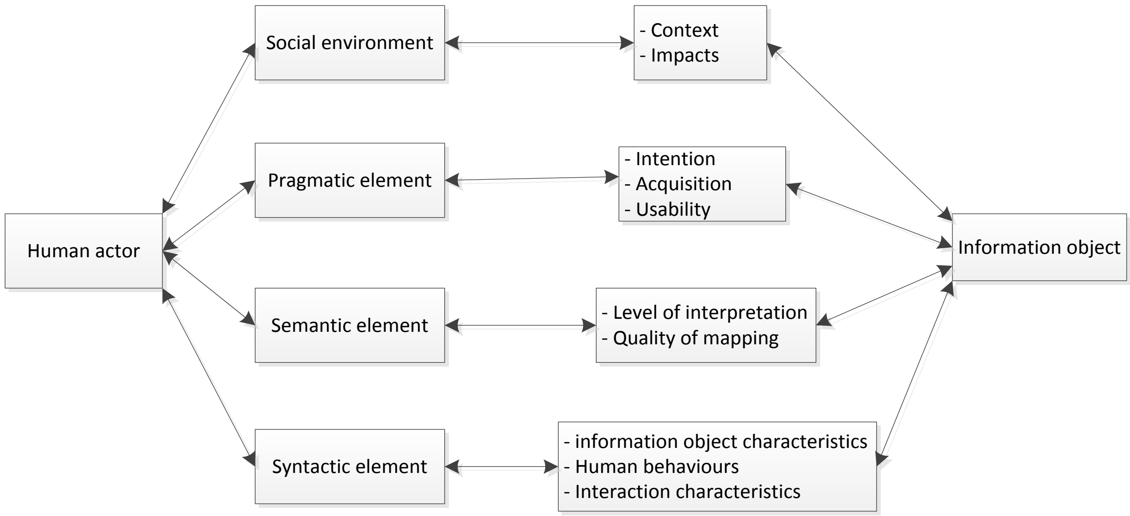


Figure 2.80: The Components of HII

The syntactic element is concerned with the representation of the interaction. In other words, this element is a set of descriptions about the involving parties and how they form the interaction. It consists of three components: information object characteristics, human behaviours and interaction characteristics. The syntactic element also represents the physical and empiric aspects of the interaction, for example interactive format or interacting dimensions (Cool & Belkin 2002). The three main sub-components of the interaction characteristics are measured by the medium of interaction, which is the format of information object (speech, text, video, image, sound); the mapping, that is the number of links between user and information object, which could be one-to-one, one-to-many, many-to-many, and many-to-one (Sjöström & Goldkuhl 2004). There is also the need to consider the mode of the interaction that is whether it is direct or indirect (mediated).

Another syntactic component of the HII worth considering is the behaviour of the user (Cool & Belkin 2002; Marchionini 2008). This include the type of action performed on the information such create, disseminate, organize, preserve, access, evaluate, comprehend, modify and use. In addition to this, the means of the behaviour is also worth considering, which among other things explains how the user interact with the media, according to the behaviour and interaction medium, that is documenting or writing (for example 'create a text'). The final stage of the behaviour of the user is interacting with the content. This includes such activities as registering, compilation, combination, interpolation, induction, deduction, interpretation, recognising, arguing, etc.

The third component of the syntactic element worth considering is the characteristics of the information object (Cool & Belkin 2002; Marchionini 2008). This include answers to questions that bother on the medium of the information, that is the physical forms of the expressing the information whether as image, drawing, written text, physical signs, oral speech. The is also the need to consider the quantity of the information object, that is whether it is one object, or sets of objects; the level, that is whether the information is in part or whole; the systematicity of the information, that is whether it occurs randomly or systematically; then the degree of the information object, that is whether it is selective or exhaustive and finally the rules of conformance whether it is alphabet, time, met-data, etc. The researchers believe that if these syntactic elements are built into the interfaces of information systems, it will enhance the quality of information representation and ultimately the user interaction with information in information systems.

It must be noted that the problem of missing context can be traced to the behaviour of the human actor, how he/she interacts with the object or event in the environment and the characteristics of the information that is eventually captured and stored in the IS/IT. The interaction characteristics identifies how the human actor perceives and interact with the object or event in the environment. For example, the mode of interaction (i.e. is the user directly or indirectly interacting with the object in the environment); medium of interaction (i.e. what is the format of the users interaction with the object and format of input into IS/IT system – is it via text, video, etc), and mapping of the external object into the information object in the IS/IT system. The problem of missing context in stored data in IS/IT systems starts at the syntactic layer of the semiotic framework. A summary of the syntactic components, the key constructs and descriptions are shown in Table 2.3.

Table 2.3: Syntactic components, constructs and measures of HII

Components	Constructs	Description (measurement items)
Interaction characteristics	Medium of interaction	Interactive format of information object: i.e. speech, text, video, image, sound
	Mapping	Number of links between user and information object, i.e. one-to-one, one-to-many, many-to-many, many-to-one
	Mode of interaction	i.e. direct, indirect (mediated)
Behaviour of the user	Behaviour	Type of action performed, i.e. create, disseminate, organize, preserve, access, evaluate, comprehend, modify, use
	Meaning of behaviour	Interacting with the media, according to the behaviour and interaction medium: i.e. documenting or writing (example of 'create a text')
	Mode of behaviour	Interacting with content, i.e. registering, compilation, combination, interpolation, induction, deduction, interpretation, recognising, arguing (example of behaviour 'create')
Characteristics of the information object	Medium of information	Physical forms of expression, e.g. image or drawing, written text, physical signs, oral speech
	Quantity	i.e. one object, set of objects
	Level	i.e. part, whole
	Systematicity	i.e. random, systematic
	Degree	i.e. selective, exhaustive
	Rules to conform	i.e. alphabet, time, meta-data

The semantic element of the human information interface concerns the mapping between information and real-world phenomena to which the information referred. The two semantic components are level of interpretation and quality of mapping. The measures of level of interpretation are mentalistic, that is individual mapping and expected acceptance; constructivist measured by negotiable mapping and negotiable acceptance; and thirdly objectivist which is denoted by well-established mapping and common acceptance (Baron et al. 1999; Stamper 1996). The quality of mapping between information and the real-world phenomenon, which the information referred to, is measured by completeness, where information should have at least one internal meaning, unambiguity where information should match at least one external phenomenon; and correctness where the reverse mapping is exact.

The quality of information mapping must be non-redundant where there is no more than one external meaning of information and meaningfulness, where stored information in information systems has no more than one external phenomenon (Price & Shanks 2004). In effect high quality of mapping enhances the users understanding of information; and a better level of interpretation of information is achieved if the mapping is agreed, accepted and believed by other users of the information. A summary of the semantic components, the key constructs and descriptions, which could be developed into metrics for assessing the quality of human information interaction, are highlighted in Table 2.4.

Table 2.4: Semantic components, constructs and measures of HII

Components	Constructs	Description (measurement items)
Level of interpretation	Mentalistic	Individual mapping expected acceptance
	Constructivist	Negotiable mapping, negotiable acceptance
	Objectivist	Well-established mapping, common acceptance
Quality of mapping	Complete	At least one internal meaning
	Unambiguous	At least one external phenomenon
	Correct	Reversed mapping
	Non-redundant	No more than one internal meaning
	Meaningful	No more than one external phenomenon

The problem of missing context in stored data at the syntactic level becomes even more pronounced since this creates information gaps at the semantic level when the stored data is retrieved for information activities. Similarly, at the pragmatic level, the missing context in stored data and the subsequent information gaps creates a huge deficiency when users retrieve information from IS/IT systems to engage in knowledge activities. There is therefore pragmatic or knowledge gaps in information and knowledge derive from stored data in IS/IT systems.

The pragmatic element of the human information interface concerns the human intention and acquisition for using information, as well as the usability of the information. The intention component of the pragmatic element, highlights the purpose of the interaction or the intention for using information when a user accesses information from a system (Hawizy et al. 2006; Blandford & Attfield 2010). The need to understand the intention of the information creator in the information systems is equally important for understanding the context of the information and be able to use it purposefully.

The acquisition component is made of the complexity of the information interaction in terms of the degree of skill, knowledge and training needed by the user for a successful information interaction process (Barron et al. 1999). The scope of the interaction which relates to the range of additional information sources needed by the user (Barron et al. 1999); as well as the method used or the process of acquiring the information (Kraaijenbrink & Wijnhoven 2006), are the other two acquisition factors worth considering in information systems design. The third pragmatic component has to do with utility of the information accessed from the information system (Abran et al. 2003; Scholtz 2006). The usability of information is measured by the effectiveness and efficiency of the user in adequately making use of the information accessed from a system (Ong & Lai 2007). Effectiveness is evaluated against the improvement of work quality (Scholtz 2006) as well as the relevance of the information in meeting the intentions of the user. An efficient information interaction process is measured by the behaviour, acquisition or learnability, accessibility and presentation of the information in relation to usage. A summary of the pragmatic components, the key constructs and descriptions had been listed in Table 2.5.

Table 2.5: Pragmatic components, constructs and measures of HII

Components	Constructs	Description (measurement items)
Intention	Intention	The purpose of interaction, user intention, intention of the information creator
Acquisition	Complexity	Degree of skill, knowledge, and training needed
	Scope	Range of additional information sources needed
	Method	Process of acquiring information
Usability (utility)	Effectiveness	Measures: improvement of work quality, and relevance to the intention
	Efficiency	Measures: behaviour, acquisition or learnability, accessibility, and presentation related to the usage

There are two initial components of the social environment identified: interaction context and interaction impacts. The interaction context may include the task space, work domain and organisational environment, whilst the interaction impact of the human information interface considers the intended, embedded and perceived impacts of information.

Acknowledging the communicative view, the output consequences of information interaction should be compared with the initial intention with which the information is created, as well as the content being carried in the information object. Thus, three types of impacts transferred throughout the information interaction can be identified. They are the intended impact of the information creator(s); the embedded impact in the information object(s); and the perceived impact of the information user(s). It is assumed that the result of an interaction can be evaluated according to the degree of matching in the three impacts at semantic and pragmatic levels. Clearly, the possibility of matching of these impacts is affected by the characteristics of the participating actors, for example knowledge and experience. These impacts also depend on the context to which the interaction belongs, thus contextual and situational attributes strongly affect the matching (Byström & Hansen 2005). This may include the task space, work domain and organisational environment among other settings (Olsen Jr. 2010; Pettigrew et al. 2001; Vicente 1999). The components of the social environment, the key constructs and descriptions are shown in Table 2.6.

Table 2.6: Social environment components, constructs and measures of HII

Components	Constructs	Description (measurement items)
Interaction context	Task space Work domain Organisational environment	Identified by contextual & situational attributes
Interaction impacts	Intended impact Embedded impact Perceived impact	Measured by semantic & pragmatic mapping between the types of impacts

The social environment components and constructs assesses the impact of knowledge activities when knowledge derived from IS/IT systems is applied to a situation or context. If there are missing context in stored data in IS/IT systems and this creates information gaps, then the knowledge derive from IS/IT systems becomes questionable. This informed the main research questions as to why there are misconceptions about the true value of knowledge derived from IS/IT systems.

2.4.5 Implications of the HII Components

A semiotic inspired components and constructs of human information interface has been identified. Not only does it acknowledge the physical representation of data and the semantic or meaning making process, but also the pragmatic and social impact of information. The human information interface can be considered similarly to the abstract concept of 'information space' (Ingwersen & Järvelin 2005), where a human actor can recognise and understand the content of information, and also evaluate his or her intention, justify information usability, as well as consider its impacts on his or her surrounding environment and work. The pragmatic and social aspects of the information interaction have not been explicitly recognised in literature. This is due to the considerably narrow view, which examines the information interaction as human behaviour instead of considering the nature of the communication between information object and human user.

The HII components identified responds to the suggestion of exploiting semantic and contextual attributes of information, as well as considering the independence of information and technology in information science (Jones et al. 2006) contrary to the opinion of Kamata et al. (2003). Further, the HII components identified have highlighted some important issues in analysing the interaction between human users and information objects, including:

1) describing the interactive process between human actor and information object, and suggesting criteria for evaluating such interaction

2) explaining how information is being interacted with, and

3) suggesting methods to evaluate the impact of the information being interacted with, and
4) suggesting measures or constructs and items, which could be developed into metrics for assessing the quality of human information interaction.

The HII components identified is shows a multi-layer interface approach which acknowledges that human information interaction is a complex process, which needs to be examined from different perspectives simultaneously. The multidimensional characteristic of information interaction has been mentioned in prior works, although with a limited view. Particularly, traditional approaches in information science have examined the interaction from only the human side, such as human information behaviours (Pettigrew et al. 2001; Wilson 1999), the cognitive gap (Zhang 1999) or the process of satisfying information need and making sense of information (Blandford & Attfield, 2010). Other issues may also be concerned such as work and task (Fidel & Pejtersen 2004) or the temporal and social dimensions (Blandford & Attfield 2010). However, the concept of information is often embedded in the process of interaction, thus each of these works can consider only a limited number of characteristics of the information; the information object is often omitted. By contrast, the semiotic approach provides a holistic perspective of the interaction with information. Experiences from prior works can be integrated to these semiotic branches in order to analyse every aspect of the communication between entities of the interaction; but not necessarily through an information device as proposed by Kamata et al. (2003).

In addition, another value of the HII components identified is the view of 'information as sign' also shows its applicability in understanding the concept of information. Information has been considered in different senses: information as thought and memory (knowledge); information as communication process (acts); information as artefact (thing); information as energy (change); or information as identity in cyberspace (Marchionini 2008 2010). However, the understanding of information is narrowed down when its meanings are separated. For example, information can be used or exchanged when it is a thing, but it needs to be seen as knowledge to be understood. Moreover, the view 'information as thing' has been criticised for looking only at the physical representation of information (Dillon 2005; Marchionini 2010) although seeing information as an artefact may help to simplify the examination of user behaviours, especially from the psychological approach (Fidel et al. 2004). By contrast, the relations between syntactic, semantics and pragmatics help to analyse all aspects of information as a whole. Information, as a sign, can be recognised in mental or physical representation; its meaning could be mapped with a real object or event, and this meaning can be purposely interpreted and exchanged.

Furthermore, another value or application of the proposed HII components and constructs is in the improvement of information media quality (Kamata et al. 2003). By analysing each element of the interface, the problems caused by missing links between a human actor and information object may be identified and improved. Obviously, these semiotic elements and components may affect each other; for example, the user's intention and acquisition may be varied in different types of social environments. However, the result of tracing and identifying those problems would be useful to optimise the information media. The model might also be expanded to improve the communication between information systems. For example, considering the potential mappings between information objects and real-world concepts would help to develop a set of criteria for the interoperability between systems. The mappings can be developed at any semiotic element, especially at the pragmatic and social levels. Although human factors are dominant at the high levels of the interface, the ability of automatic interpretation would help information systems to provide better services to human beings.

2.4.6 Limitations of the Proposed HII Components

Although the semiotic approach has advantages in modelling the interface, we acknowledge that our model is limited to examining the static nature of data and information. In our work, data and information have been seen as 'static' signs and carried by sign-vehicles. However, information representation and the mapping of meaning can be changed instantly throughout the interaction, and so are the context and social impacts. We agree with the assumption of Marchionini (2004), that the emphasis should be placed more on the flow of the changes that happen during the interaction rather than the single connection between human actors and information objects. However, we still believe that the HII model is applicable in examining the interaction at specific points of time in such a dynamic process.

The HII components identified by no means establishes a comprehensive set of factors that determine every aspect of the human information interface and interaction. For example, the cognitive process, through which people become conscious of things and establish the need for interacting with information, is excluded. We can understand the reason for interaction through the intention of the information user or the intended impact of the information creator; however, we are unable to answer how such intention might be triggered. We assume the solution may come from studying the psychological characteristics or educational background of the human actor. Additionally, the effects of the physical environment on information interaction are not included in the construction of the human information interface. Although they can be analysed by using a suitable framework (Shneiderman & Plaisant 2010), such effects are related to the interaction with the information system with a focus on the quality of the information system hardware.

The deficiencies in stored data at the syntactic, semantic and pragmatic levels of information are highlighted with an initial conceptual model of human, information object and information system interaction. This literature review then introduced a model of interface for human information interaction based on the semiotic framework. Particularly, ten components of the human information interface are categorised based on syntactic, semantic, pragmatic, and social environment elements. Important consequences of modelling the human information interface include understanding the nature of interaction as well as developing a set of principles to analyse and evaluate the interacting process. These consequences are very important for the design and management of intelligent information systems in the new era of technology.

The key problem the proposed HII components intends to solve is the context of information, which is usually missing when data is stored into an information system. In other words, how can information systems be designed to be adaptable to the user's pragmatics requirements and social environment? The authors opined that a possible solution would be to build context into the data interface or build a common knowledge interface into the output sub-system in order to ensure that the intended impact of the information creator informs the intentions of the information user. This section of the literature review has identified key constructs and measurements items, which could be developed and tested empirically and used as a tool for assessing the quality of human information interaction. We also believe that the HII components and constructs identified would provoke further studies, which seek to solve the problem of context information, which is usually missing when data is stored in an information system.

We conclude this section of the review by defining human information interface (HII) as:

> "*the point of interaction between human actor and information object where optimal understanding (semantics) of information is achieved through the availability of context-based data to enhance the usability (pragmatics) of the information".*

To the best of our knowledge, the concept of human information interface (HII) has not been explicitly defined in literature as at the time of writing this thesis. Our definition of HII therefore provides valuable contribution to information interaction and IS literature and serves as a foundation for a paradigm shift from HCI to HII studies. We believe HII to be an entirely new discipline, focusing more on those human information functions in human information interaction, which are beyond the purview of HCI.

2.5 Characterisation of Knowledge and Knowledge Activities

Knowledge management (KM) has attracted enormous attention over the last two decades (Alavi & Leidner 2001) because of its significance and the general shift from the information society to the knowledge economy (Nonaka 1994). The benefits of knowledge and KM to both the individual (Erzetic 2008; Lin 2007; Cordoba & Isabel 2004; Bock et al. 2005; Chang et al. 2008), business (Chow & Chan 2008; Uotila & Melkas 2007) and society (Mohd & Nor 2012) have been acknowledged.

Studies have shown how knowledge sharing can improve individual and organisational performance in the business environment (Cross & Cummings 2004; Bock et al. 2005; Kang et al. 2008). For example, Au (2011) examined the role of knowledge sharing practices on individual work performance of public employees in Hong Kong. The study noted that individual knowledge sharing behaviours supported by positive attitudes significantly influences individual performance. In a related study, Quigley et al. (2007) established a positive effect of knowledge sharing on performance. Hsu (2008) argued that organisational knowledge sharing could lead to improved organisational human resource development, which may lead to improved organisational performance. The result of the study shows a correlation between organisational knowledge sharing and organisational human resource development and organisational performance.

A study by Fugate et al. (2009) also reveals a positive relationship between improved knowledge management in logistics operations and organisational performance. In addition, Kang et al. (2008) investigated the correlation between knowledge sharing and individual performance in a public-sector organization in South Korea. They concluded that knowledge sharing significantly influence work performance. They also established the mediating role of trust in knowledge sharing and work performance. Based on evidence from existing literature, it can be argued that knowledge sharing can improve an individual’s adjustments in socio-economic life and therefore must be promoted.

Existing literature shows quite a diverse range of issues on knowledge management being given attention. Knowledge management is thus generic in concepts but multi-disciplinary in content and application. Although knowledge has its roots in philosophy and religion, many more disciplines have emerged and continue to evolve from KM concepts (Wiig 1997, 1999; Alavi & Leidner 2001). For example, Knowledge Engineering, Information Systems Engineering, Knowledge Science, Human Systems Interface, Cybrary, etc, are all considered as offshoot of KM (Sagsan 2009; Wiig 1999).

Scholars have tried to define knowledge from different perspectives. For example, knowledge is knowing and the reason for knowing (Wiig 1997, 1999). The debate as to what really is knowledge, where does it originate from, how is it generated, utilised, and preserved (Wiig 1993) etc. continue to dominate some areas of the KM discourse. Knowledge has been characterised within several context, time and space. According to Nonaka & Takeuchi (1995), knowledge types are exclusively explicit and tacit, but Mozuriuniene et al. (2013) identifies an additional type called implicit knowledge. Other scholars have conceptualised and categorised knowledge in different forms, types and kinds such as subjective, objective and empirical knowledge (Karwowski & Ahram 2009); managerial and technical knowledge (Narteh 2008).

Knowledge has also been categorised at the organisational level. For example, Fitzgerald (1992) and Nosek (2004) propose three significant categories of knowledge relevant to the organization's capacity to act. These are static knowledge, which includes unchanging, facts, existing independently of the knower, located in the world as discoverable "truths". Dynamic knowledge, which covers changeable facts, cognitions, feelings, and emotions, dependent on the knower, located in the mind (tacit) with possible various "correct" versions of the truth. Knowledge may be created and is inherently subjective. The third category is hybrid knowledge, the product of the knowledge system at the point where the knower interacts with the world.

The characterisation of knowledge processes are based on the focus, goals, expectations, and values that is attached to knowledge (Tiwana 2000). It also shows the relativity in terms of the source and destination of the knowledge, and the desire or goal to achieve a balance between these perceived gaps based on the rationality of the person involved in the knowledge activity. It is for these reasons that knowledge has been characterised as process such as knowledge integration (Karwowski & Ahram 2009), knowledge donating (Van den Hooff & Van Weenen 2004b; Jantunen 2005), knowledge sharing (Ardichvill et al. 2003; Van den Hooff & Van Weenen 2004b), knowledge diffusion (Magnier-Watanabe & Senoo 2008), knowledge transfer, knowledge creation, archiving, storage, utilisation, etc. (Tiwana 2000). Therefore, knowledge activities can be viewed from the time, space and value dimensions relative to the person involved in the knowledge activity.

2.5.1 Knowledge Management within defined Environment

The notion of environment has diverse meaning within different context. It defines activities within a defined context. Social environment, physical environment, ecological environment and many more descriptions of the environment can be identified. Environment can influence activities and determine outcomes. The environment is context specific and may include sub-classes of location, time, networks, physical set-up, etc. (Hu & Li 2009; Wong 2005). According to Bosua & Scheepers (2007), knowledge sharing is an exchange of knowledge between its origin and destination within a specific context. It is seen as a dual process of enquiring and contributing to knowledge through activities." This emphasis the context specific nature of knowledge management, therefore understanding the interactive effect of the human-environment fit, would enable individuals and organisations to design appropriate behaviours to maximise adjustments and knowledge for improved performance.

From a social context, environment depicts the way of life of a group of people. This is usually ingrained in rules and beliefs of the people, which guide their behaviour. The environment thus influences the development of the individual. Although researchers have acknowledged the importance of the environment in KM, the focus has been varied. Some scholars have looked at only the social factors of KM (Thou 2002; Huerta et al. 2012) the economic or a mix of these factors. For example, Chu & Suliman (2002) studied the social and economic factors of knowledge sharing.

The terms knowledge, internal and external environment, collaborative, operational environments (van Winkelen & McKenzie 2010) have been proposed, whilst the concept of business environment has dominated most knowledge management literature (van Winkelen & McKenzie 2010; Cabrera et al. 2006; Al-Alawi 2007; Cogliser et al. 2012). The need to understand the broader environmental factors that impact on KM activities have been emphasised (Hu & Li 2009; Karwowski & Ahram 2009; Wong 2005; Syed-Ikhsan & Rowland 2004).

The environmental factors that may impact on knowledge management activities undertaken by individuals may be tied to technology (Kwan & Cheung 2006; Sveiby & Simons 2002; Sambamurthy & Subramani 2005; Wong 2005; Karwowski & Ahram 2009; van Winkelen & McKenzie 2010; Cabrera et al. 2006; Wangpipatwong 2009), rigidity of the environment in terms of openness (Wong 2005), and diversity or stability (Heng 2000; van Winkelen & McKenzie 2010). While acknowledging that the environment and the human factors are intricately linked, their ability to predict the knowledge activities that an individual may engage in depends on the focus and goals of the individual (Karwowski & Ahram 2009, Barrick et al. 2013).

Human beings live in an environment over time and space. The environment is bounded by norms, which guides the activities of people. The questions as to why we desire knowledge could be answered from the perspectives of the innate desire to succeed, survive or adjust to situations. This analogy may be linked to the question as to why people engage in knowledge activities (creation, sharing, transport, transfer, utilisation and archiving); could it be because our environments are sometimes unstable, uncertain, and heterogeneous? The degree of diversity and stability of our environment invokes that innate desire to engage in knowledge activities at different times in order to archive a balance. This emphasises that indeed humans are biological beings (Heng 2000).

Human beings are always dynamic expressions of the environment they found themselves in, exhibiting rationality and meaning seeking tendencies through diverse communication modes. According to Stamper (1973), “society is a fabric woven from threads of communication”. Scholars (Thomas et al. 2001; Cabrera et al. 2006; Al-Alawi 2007; Hu & Li 2009) have confirmed communication ability and capacity of the individual in knowledge activities. The decision to engage in knowledge activities may be influenced by the presentation of knowledge, interest, readability and the value (Heng 2000) assigned to that particular knowledge activity.

Knowledge activities are purely human centred and are therefore intricately linked to identifiable behavioural factors within particular cultural and social context (Thomas et al. 2001; Karwowski & Ahram 2009; Cabrera et al. 2006). Human factors affecting knowledge management include but not limited to skills, abilities, capabilities, attitude (Mozuriuniene et al. 2013; Huang et al. 2008), motivation (van Winkelen & McKenzie 2010; Al-Alawi 2005; Huang et al. 2008), qualification (Karwowski & Ahram 2009), self-esteem, assertiveness, trust (Al-Alawi 2007), perception (Liang et al 2008; Kankanhalli et al., 2005) and personality (Al-Alawi 2007) among others. For example, the Five Factor Model (FFM) personality traits namely openness to experience, extraversion, agreeableness, conscientiousness, and emotional stability, have been used by several researchers and found to be very robust in understanding human factors in knowledge activities (Cogliser et al. 2012; Barrick et al. 2013).

For example, Huerta et al. (2012) and Mozuriuniene et al. (2013) identifies individualistic and collectivist cultural factors to reflect the human attributes of the actors involved in the knowledge management activity. It has also been established that people who are eager have a strong internal drive to communicate their knowledge, regardless of the group’s goals or any direct tangible benefits they can expect from it (Von Hippel 2001).

The importance of communication in knowledge activity has thus dominated knowledge management literature. For example, Chen et al. (1998), argue that those eager to share knowledge prefer verbal and ‘lean’ communication and focus on their own views for creating a common view (Ting-Toomey 1988). Some researchers and practitioners noted that knowledge sharing depends first and foremost on communication skills both verbal and written (Riege 2005). It is easy to transmit explicit knowledge through formal language and can be made readily available in the form of files, library collections, or databases (Nonaka & Takeuchi 1995).

Literature shows that knowledge management activities are environment dependent. For example, it has been asserted that if communal sharing of knowledge is usual within an environment, a knowledge-sharing culture will be apparent, and it will urge people to share valuable knowledge with each other (Potgieter et al. 2012). According to Nonaka & Takeuchi (1995), "Knowledge sharing culture consists of collection and combination of ordinary expectation, share experience, tacit roles and social standard and norms that create our attitude and behaviours".

Knowledge activities (KACT) have been defined differently by different scholars in different context (Lew & Yuen 2014; Granados et al. 2017; Matusik & Heeley 2005; Beesley & Cooper 2008; Sowe et al. 2008; Lew et al. 2013; Heavin & Adam 2012; Lai & Lee 2007; Morettini et al. 2013). For example, Granados et al. (2017) defined it to include activities such of acquisition, conversion, application and protection of knowledge. According to Heavin & Adam (2012), KACT's include those activities related to how one can acquire, codify, store, maintain, transfer and create knowledge; whilst Morettini et al. (2013) operationalised KACT's as R&D, patents and publications. However, for the purpose of this study, knowledge activities is defined as the acquisition, capturing, storing, reusing, externalising, stimulating, identifying new knowledge, and leveraging of knowledge for new opportunities (Matusik & Heeley 2005; Lai & Lee 2007; Beesley & Cooper 2008; Sowe et al. 2008; Lew & Yuen 2014; Lew et al. 2013; etc.).

2.5.2 Models of Human-Environment Fit and Knowledge Management

Several attempts have been made to model the environment-person fit and knowledge management. Whilst some studies were silent on the environment and explored only the person-knowledge activity model, other scholars also explored only the environment-knowledge activity fit (Mozuriuniene et al. 2013***)***. A few scholars (Thomas et al. 2001; Al-Alwawi 2007; Huang et al. 2008; Karwowski & Ahram, 2009) have, however, explored both the person-environment fit model but did not ascertain the interactive effect of these two factors on knowledge activity. For example, Al-Alwawi (2007) used the Organisational Culture Framework based on the work of Gupta & Govindarajan (2000) and modelled knowledge sharing as a function of the person (motivation, trust and communication); and the environment or culture (organisational structure, reward, information system, processes, and leadership). In addition, Karwowski & Ahram (2009) used the Human System Integration (HIS) knowledge management components as a framework to model HIS knowledge as consisting of as human factors, systems and processes and technology integration.

Different models have been used to explain human behaviour in different settings, systems and situations. The dominant models, which have been used in knowledge management studies, include the self-efficacy theory (Endres et al. 2007); Theory of Planned Behaviour or the Theory of Reasoned Action (Bock et al. 2005; Chang et al. 2008). In addition, the Social Exchange Theory has been popular in explaining knowledge management in organisations (Kankanhalli et al. 2005; Liang et al. 2008). Considering the limitations of using single models or theories to explain complex human behaviour, other scholars have used a mix of these models in an attempt to increase the validity and reliability of their research output by offsetting the disadvantages of one theory with the advantages of the complementary model.

The model of reciprocal causation posits that behaviour, cognition and personal characteristics, and environmental factors operate as interacting effects that affect each other bi-conditionally (Bandura & Adams 1977; Bandura 1986; Neisser 1976; Cabrera et al. 2006). Therefore, integrated models that incorporate the reciprocal causation of multiple factors within the environment and the different attributes of the individual were considered appropriate in understanding the human-environment fit in knowledge management studies. In this regard, the systems theory of human behaviour, which focuses on how persons interact with their environment (Hutchinson 2003), was deem appropriate for this study.

2.6 Theoretical Considerations for the Study

The choice of an overarching theory for the study has been explored. The considerations included the Systems Theory of Human Behaviour which explains how persons interact with their environment (Hutchinson 2003) and the Social Constructionism Theory which explains how socio-cultural and historical context shape individuals and knowledge creation (Hutchinson 2003; Robbins et al. 2005). Other theories considered were the Activity Theory (Engestrom 1987), which considers an entire work/activity systems and accounts for environment, history of the person, motivation, culture, role of artefacts, and complexity of real life. The study adopts the Systems Theory of Human Behaviour (Hutchinson 2003) as the main theoretical underpinning, whilst using the Organisational Semiotics (Stamper 1973) as an analytical framework to understand the issues relating to objects, signs, meanings and usability of information stored in information systems.

According to Hutchison (2003) the Systems Theory of Human Behaviour, which includes ecological systems, offers a general systems perspective to human behavior in an environment. The main concept of this theory is that persons are in continual transaction with their environment. Systems are interrelated parts or subsystems constituting an ordered whole each subsystem impacts all other parts and whole system (Hutchison 2003). The systems theory also acknowledges the limits of human behaviour in relation to the type of systems. It argues that systems can have closed or open boundaries, and this has implications for human behaviour. In addition, human behaviour with systems is incline toward achieving stability (Hutchison 2003).

The practical relevance of the Systems Theory of Human Behaviour (Hutchison 2003) include developing holistic view of persons-in-environment phenomenon. It is also useful for enhancing understanding of interactions between micro-meso-macro levels of a system similar to the syntactic, semantic, and pragmatic levels as in this study. In addition, the systems theory enriches contextual understanding of human behavior akin to the mediating role of human user in the human information interface. A notable intervention practice of the systems theory is in creating stability in a system by strengthening one part of the system or subsystem to impact the whole system.

In relation to this study, it is assumed that an object in the environment has identifiable context details such as “what”, “when”, “how”, “why”, “where”, “what” and “situation” (Dey 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa 2003) but when the object is captured as a sign into IS/IT systems, only limited details are available. The need to achieve balance between context of an object in the environment and its representation in the form of a sign as data in IS/IT systems in relation to the human user with semiotic capabilities is the core theme of this thesis.

The second theoretical consideration for this study is the semiotic framework and serves as the nexus between the human actor and the information system (IS). IS have been described as repositories of organisational activities, events and happenings. IS captures and represents these activities, events and happenings in the form of “signs” (Liu 2000). In addition, a notable theory that explains signs and their meanings is semiotics (Peirce 1931-35). In the field of management, semiotics has been widely used in IS (Stamper 1973, Liu 2000). Although Peirce’s Traid Semiosis identifies the sign, object and the interpretant, these have been extended to six layers of two worlds, the IT platform and the human information functions (Fig. 2.11). The study is, however, situated within the syntactic, semantic, pragmatics and the social world layers, to provide a foundation for a higher-level consideration of the proposed HII, which is the focus of this study. Therefore, at the HII level, Peirce’s Traid of Semiosis becomes more relevant as the IS/IT “disappears” leaving the “human” to interface with “information”.

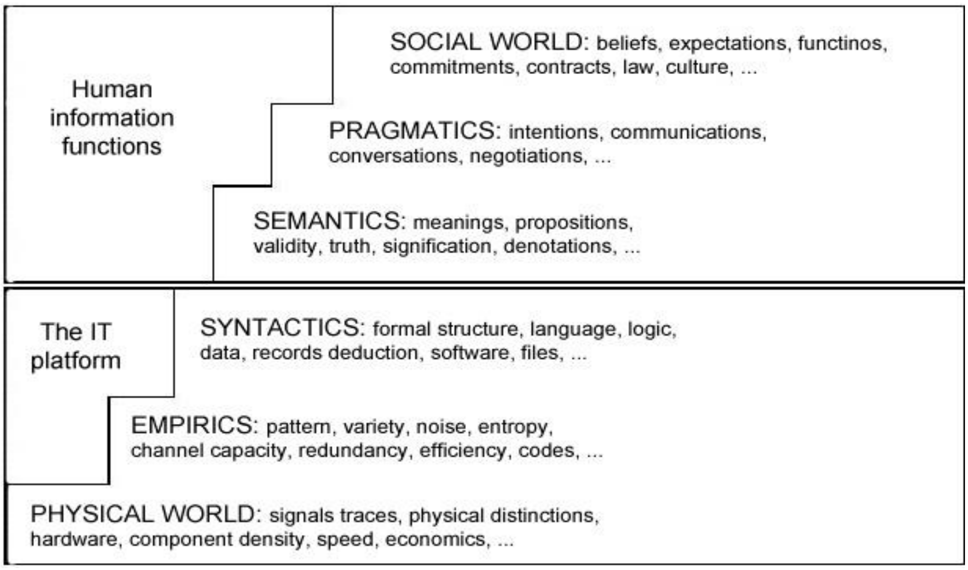


Figure 2.9: The Semiotic Framework (Stamper 1973; Liu 2000)

Inspired by considerations of the semiotic framework and the systems theory of human behaviour, a bigger picture of the study is shown in the conceptual framework in Fig. 2.12. The human actor interacts with an IS through HCI. This normally involves data capturing and representation. The HII is conceived as the semantic and pragmatics of information where meaning is ascribed to stored data to generate information and knowledge. The impact and contextualization of the information comes from engaging in knowledge activities in the environment.

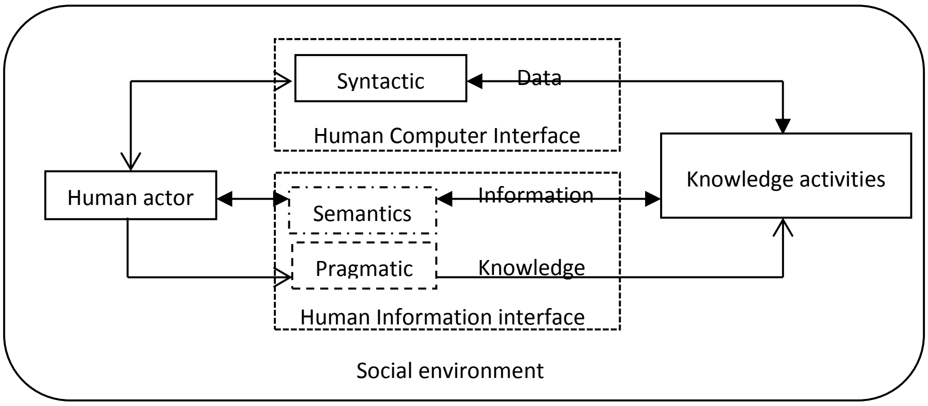


Figure 2.10: Model of Human information interface for knowledge activities

The entire set-up can be considered as a system, with the human actor, IS and the environment as sub-systems (Fig. 2.12). The human actor exudes semiotic capabilities which are used to interact with IS and the information object. This justifies the choice of systems theory and the semiotic framework as the main theoretical underpinnings of this study.

2.7 Problem Statement and Research Gap

This study is grounded on the assumption that events (data or information and knowledge) emanates from and impacts on the environment. The environment could be business, the larger social environment or an internal environment relative. Therefore, certain factors in the social environment affect both the human actor and information object. The question therefore is what social environment factors are functions of context; and how can these be incorporated into the data and information interface to enhance knowledge activities? The context information based on the social environment could centre on the "how", "why", "situation", "who", "when" as well as "where" about an object or event.

At the syntactic level, where the event is represented in the IS/IT system in the form of a "sign" or the "what" about the event; can interfaces and the corresponding databases be designed to also capture and store the "who", "situation", "how", "when", "where" and "why" about the event? How can the constraints imposed by the current challenges of HCI be overcome so that more context-based data and context-based information can be stored in IS/IT systems for knowledge activities?

The inadequate context information at the syntactic level creates even more challenges for the human actor when an attempt is made to retrieve the stored data (“what”) for information and knowledge activities. Due to the missing context, the human actor is compelled to impose some assumed context (“who”, “situation”, “how”, “when”, “where” and “why”) about the data captured “what” into the IS/IT system in order to make meaning of the data and create information as well as engage in knowledge activities. There are therefore huge semantic and pragmatic gaps when the human actors retrieve stored data from IS/IT systems for information and knowledge. The context deficiencies in stored data in IS/IT systems undermines the value of knowledge activities from artificial intelligence (AI), expert systems, intelligence of computers, programming, data analytics and intelligence and those other activities that rely on stored data.

The semantic and pragmatic layers are conceived as the main block of the human information interface (HII) which is the focus of this study. The case for HII as an emerging disciplined is informed largely by the limitations of current interfaces provided by HCI; which only enable the syntactic representation of data as a one-dimensional entity (“what”) contrary to the multi-faceted nature of data (including the “who”, “situation”, “how”, “when”, “where” and “why” about the data as part of the “sign” stored in the IS/IT system). The need to move beyond HCI is also necessitated by the “disappearing computer” and shift towards an increasing attention on machine learning, and natural language processing and those complex human centered activities.

The greater part of human activities happens within the scope of the human-information functions rather than the IT functions as per the semiotic framework of Stamper (1973) and Liu (2000). Although, Stamper (1973) acknowledged that issues within the human information functions are difficult to pursue as these borders on human behaviour, norms and informal activities within the social world, we believe that the human information issues once operationalised can be investigated. However, the scope of this research is more on the semantic layer, focusing on the human information interface. The consideration of the factors in the syntactic, pragmatics and social world were meant to demonstrate the interdependencies between data, information, and knowledge within social world. The semiotic layers are very much inseparable and human beings are semioticians in all facets of life.

A human actor relies on stored data in IS/IT systems through HCI to generate information and knowledge based on assumed context within the HII domain for knowledge activities. However, there are misconceptions about the true value of the knowledge activities given that the information and knowledge created are based on stored data, which is deficient in context. The question therefore is how more contexts can be built into the data and information interface to enhance the quality of knowledge activities. The next chapter focuses on the methods to be used in developing the conceptual framework as well as the approach to collecting data for developing the HII framework.

The evidence from existing literature and the data for the study highlights the challenges of current IS with respect to the inability of the current design of HCI in achieving adequate representation of data/information in IS. We perceive this as the major challenge that raises concerns about the long-standing issues of data and information quality in IS as well the value of knowledge activities derived from stored data and information in IS. The authors also consider this challenge as a fundamental hindrance in achieving truly intelligent systems and real IA systems, the resolution of which would make for the design of context-aware IS. We therefore proposed and defined the new concepts of HII and HKI, which hitherto has not been defined in existing literature. HII and HKI are thus only emerging disciplines which seeks to provoke further studies focusing more on the human role in the capture, processing and use of sign and meaning to represent phenomenon in IS and IT systems. An initial attempt to solve the current challenge of IS has been proposed where data representation is conceived as multi-dimensional using the principles of matrix and vectors inspired by semiotics.

Existing studies (e.g. Brazier et al. 2000; Anderson et al. 2015; Tenopir et al. 2011, Cappiello et al. 2003) have highlighted the issue of lack of context in stored data in IS/IT systems, however, there is as yet no framework that establishes the elements of context and how this impact on the quality of data, information and knowledge derived from IS/IT systems. In addition, there is no formal definition of context-based data, context-based information and context-based knowledge. There is also no framework that shows the interface between human factors, interface

2.8 Chapter Summary

The literature review has established evidence of the problem of missing context (Dey 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa 2003, Dzandu & Tang 2015; etc.) in stored information in current IS based on existing HCI interfaces. The current interfaces of IS provided by HCI approaches are technically oriented, data driven and at best only capable of syntactic representation of data/information. The review has clearly highlighted evidence of the problem of missing context from the debates on the data-information-knowledge trichotomy and operationalised the concept of knowledge activities (Beesley & Cooper 2008; Matusik & Heeley 2005; Sowe et al. 2008; Bhatt 2001; Lai & Lee 2007) used in the context of this study.

The review also looked at the data-information and knowledge debate beyond the scope of human computer interface (HCI) where current technical systems depends largely on communication through language and hence interactions take places mainly via physical interfaces. A look into the interface literature (Zander & Kothe 2011; Wolpaw et al. 2000; Wolpaw et al. 2003) shows a clear departure from the language-centric interfaces to non-language-based systems and interfaces like the anticipated telepathic systems or interfaces.

The journey from HCI to HII has been highlighted and key the concept of HII has been explicitly defined. The elements and factors that constituent the interface factors which mediate the human interface with information were identified and used to produce a model of the human information interface. The larger implication of HII for knowledge activities and knowledge management have been discussed. The choice of systems theory of human behaviour and semiotic framework as integrated theoretical foundations for the study are highlighted leading to the proposed conceptual framework for knowledge activities.

Chapter 3

Research Methodology and Methods

3.1 Introduction

Research methodology is the overall logic or philosophies and principles underpinning the study as well as the research methods for achieving the results, aims and objectives of the research (Giddens 1993). This chapter discusses the methodology for the study. First, the philosophical underpinnings are examined to highlight the sets of principles used in IS research. Research paradigms are appraised, and the models adopted to guide the study to explore the research problem are outlined and justified. These include the methods, instrument and procedures used to produce the data for the study. Thus, the choice of the research design and research process adopted for the study are discussed and justified.

The entire research methodology methods, which are informed by and to the research philosophy and research paradigms (Saunders et al. 2009), is guided by a top-down structure from the research strategy, design, process and to tools and techniques (Fig. 3.1).

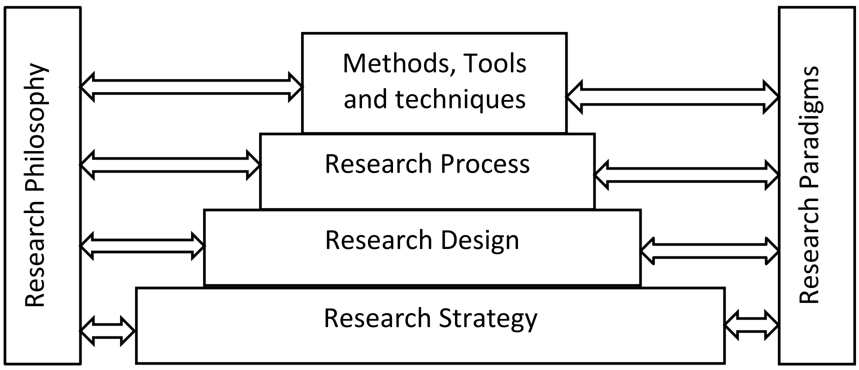


Figure 3.1: Research Methodology and Methods

Based on the research philosophy and research paradigm; a high-level research strategy is conceived; and an appropriate research design is outlined (Creswell 2009). This is followed by the research process and then the tools and techniques used to collect analyse data and present the research outcomes.

3.2 Research Philosophy

Research philosophy identifies the ways and means by which knowledge is created, disseminated, accepted and validated within various fields of research. Research philosophy describes researchers believe about how knowledge is created (Saunders et al. 2007) or could be constructed (Saunders et al. 2009). Knowledge is complex and informed by several factors in different context. For example, in Science, Arts and Humanities; knowledge is conceptualised, produced and validated differently. Information system (IS) research philosophy is deeply rooted in ontology (objectivism and subjectivism), epistemology (positivism and interpretivism), and axiology beliefs (Weber 2004; Niehaves 2007; Saunders et al. 2009). For the purpose of this study, four main philosophical underpinnings (Fig. 3.2) namely axiology, epistemology, methodology and ontology (Easterby-Smith et al. 2012; Vaishnavi & Kuechler 2004) have been discussed.

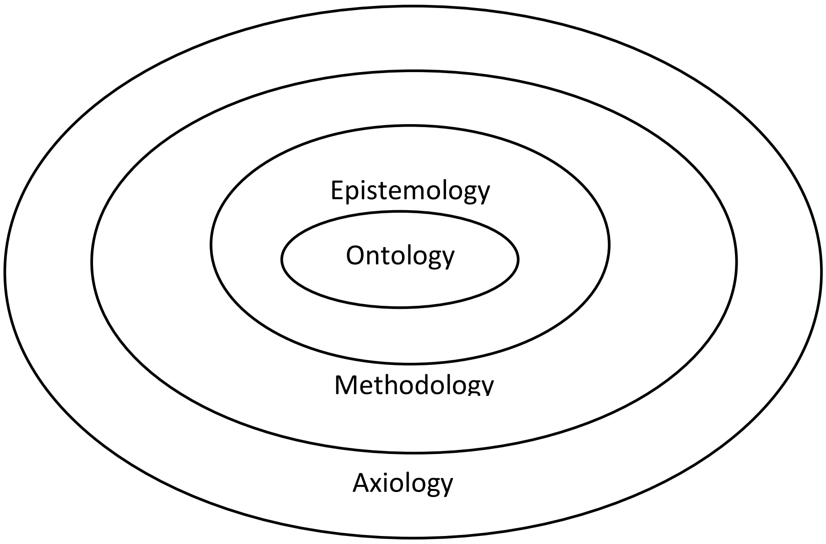


Figure 3.2: Research Philosophy Tree (based on Easterby-Smith et al. 2012).

The axiology is about values individuals hold and the reasons behind them. The axiological assumptions are concerned with the philosophical values that underlie what an individual or a group of individuals believes in and the reasons for such beliefs (Mouton 2001; Mingers 2001).

The epistemological assumptions entreat researchers to reflect on what is knowledge and the constituents of acceptable knowledge (Gorichanaz 2017; Easterby-Smith et al. 2012). The epistemological assumption explores the nature of knowledge; and what is judged to be valid or invalid, true or false from different perspectives (Easterby-Smith et al. 2012; Gorichanaz 2017). The epistemology perspective attempts to answer the question of how can researchers ascertain true and acceptable knowledge within a particular field of study? The two main perspectives of knowledge from the epistemological assumptions are objectivism and subjectivism (Easterby-Smith et al. 2012; Cornford 2003). The objectivism perspectives take the philosophical stance that the knower and the world exist independently. Subjectivism, however, takes the philosophical stance that knowledge cannot exist without a knower. Subjectivism assumes the world is artificially conceptualised and appropriately, for convenience and that the world has no real structure (Easterby-Smith et al. 2012; Cornford 2003).

Within the field of IS, the key epistemological perspectives are positivism, interpretivism (Weber 2004 Niehaves 2007) and pragmatism (Creswell 2009; Saunders et al. 2009). Positivism research assumes that reality is objective, observable and measurable (Bryman & Bell 2007). It is driven by hypotheses, grounded on quantitative measurement, and testing. On the other hand, interpretivism research, which is subjectivism, assumes that reality is based on how individuals understand and interprets phenomenon differently. It is driven by research questions/objectives and qualitative narratives. Pragmatism perspective posit that is possible to situate a research within the positivism and interpretivism and thereby used mixed methods (Creswell 2009; Venkatesh & Brown 2013) to gather, analyse and interpret data (Saunders et al. 2009).

The methodological assumptions are related to how a researcher finds out what is believed to be known. It focuses on systematic procedures that are used and can be followed to generate data, information, and knowledge to garner acceptable understanding (Easterby-Smith et al. 2012; Vaishnavi & Kuechler 2004).

The ontological postulation focuses on how to describe the nature of reality in an attempt to answer questions on what is real and what is not (Vaishnavi & Kuechler 2004; Easterby-Smith et al. 2012). The ontology perspective questions the existence or otherwise, leading to the two ontological positions namely objectivism and subjectivism. Whilst subjectivism holds that social phenomena originated from and are established by the insights and subsequent actions of people, objectivism holds the belief that in reality, social phenomena exist independently from people (Easterby-Smith et al. 2012; Saunders et al. 2009).

This study adopts the pragmatism research philosophy. This is evident in the use of mix methods and approach to collect and interpret data to address the research questions (Creswell 2009; Saunders et al. 2009). The interpretivism elements involves a critical review of literature to understand and analyse the research problem, whilst addressing the research question, i.e. whether individual culture affects data storage and information retrieval from IS/IT systems. This was supplemented with quantitative data from a survey to understand how social environment, syntactic, semantic and the pragmatics elements affects data storage and information retrieval from IS/IT systems. These helped to understand the research problem leading to the design of context-based data and information interface model. A positivist survey supplemented by interpretivist expert interviews were then used to evaluate the proposed model and the potential effectiveness of the HII framework developed. The use of the mixed methods (Venkatesh & Brown 2013) approach, thus justified the pragmatism epistemology philosophy adopted for this study.

Research philosophy together with the research paradigms; inspire the methodology to adopt for a particular research, including the methods, techniques, tools and analytical frameworks. The next section discusses key research paradigms that informed the choice of methods used in this study.

3.3 Research Paradigms

Paradigm is an approach to pursuing better understanding and knowledge about a phenomenon (Saunders et al. 2009). Research paradigm according to Kuhn (1962) is about how researchers perceives and explains the world using the appropriate rubrics and principles recognised and acceptable within a scientific discipline. Research philosophy and paradigm together provide a strong foundation for strategizing how to carry out a research, where and when to collect data, what data to collect and how, and how to enhance the acceptability, validity and reliability of the research outcomes. Although some scholars (Easterby-Smith et al. 2012; Creswell 2009; Cohen et al. 2011; Saunders et al. 2009) identifies interpretivism, positivism and pragmatism as the most quoted and dominant research paradigms, the details in Table 3.1 show four paradigms used in IS research, with each underpin by the four research philosophies.

Table 3.1: Philosophical and research paradigms

Research paradigms	Philosophical assumptions			
	Ontology	Epistemology	Methodology	Axiology
Positivist	- Single, stable reality - Law-like	- Objective - Detached observer	- Experimental - Quantitative - Hypothesis testing	- Truth (objective) - Prediction
Interpretive	- Multiple realities - Socially constructed	- Empathetic - Observer subjectivity	- Interactional - Interpretation - Qualitative	- Contextual understanding
Critical realism	- Socially constructed reality - Discourse - Power	- Suspicious - Political - Observer constructing Version	- Deconstruction - Textual analysis - Discourse analysis	- Inquiry is value-bound - Contextual understanding - Researcher's values affect the study
Design	- Multiple, contextually situated realities	- Knowing through making - Context-based construction	- Developmental - Impact analysis of artefact on composite system	- Control - Creation - Understanding

(Vaishnavi & Kuechler 2004; Adebesin et al. 2011; Terre Blanche et al. 2006; Saunders et al. 2009; Vaishnavi et al. 2013)

The four main paradigms that underlie IS research are positivist, interpretive (Creswell 2009; Weber 2004; Niehaves 2007; Saunders et al. 2009); critical realism and design science (Vaishnavi

& Kuechler 2004; Mingers 2014). The positivists school of thought aligns with the objectivist philosophy and believes that reality is observable and measurable (Creswell 2009; Bryman & Bell 2007). The interpretivists school of thought aligns with the subjectivist philosophy and believes that knowledge is socially constructed by the contexts within which it happens (Creswell 2009; Avison & Elliot 2006; Saunders et al. 2009; Weber 2004; Niehaves 2007). Critical realism avers that phenomenon occurs as structured mechanisms and can be observed and experienced (Mingers 2014; Hirschheim & Klein 1994). Design science research paradigm is inclined to identifying a problem and then developing solutions in the form of IT artefacts (Hevner et al. 2004). From these IS research, the design science research paradigm is considered the most paradigm to adopt for this perfectly.

3.3.1 Selection of Research Paradigm

Given the research strategy (in section 3.4), the choice of design science was deem the most appropriate for this study. The design science process is systematic, results-oriented, and practical. The five-step process of a typical design science research (Hevner et al. 2004), is as follows:

- Stage 1: Problem awareness - This is the first step in design science research and essential for defining the outputs of the research. The process includes identification and understanding of significant problems and how these affect people, organisation and society (Hevner et al. 2004). Sources of the problems could be practical - from personal experience, changes in industry and observations in the workplace (Vaishnavi 2008; Vaishnavi & Kuechler 2004); and from academic discourse through the review of literature on the problem.
- Stage 2: Suggestion – This stage is concerned with the approach to solving the problem identified in stage 1. It is the identification of the appropriate and rigorous methods, methodology, and techniques to ensure that the research output solves the research problem (Hevner et al. 2004). The suggestion stage may thus include the research design, methods, tools and techniques to be used and a conceptual model of the artefact and alternative solutions.
- Stage 3: Development – This stage involves the actual development of the artefact either from scratch or by the refinement of the conceptual model developed at the suggestion stage. This phase thus involves the process of probing for the optimum solution through iterative reviews and design to produce a desired artefact (Hevner et al. 2004).
- Stage 4: Evaluation - This stage involves the full evaluation of the research by different participant groups from multiple bodies and industry sectors possibly over a period of time. The evaluation stage serves as a check to ensure the artefacts adequately resolve the research

problems, meet the objectives set for the study and the solutions is complete and effective (Hevner et al. 2004).

- Stage 5: Conclusion - This is the final stage of a design science research and it involves reflections over the entire study, identifying limitations, and contributions to both academia and industry well as the communication of the research through publications.

Design science, although criticised by some scholars, is highly valued amongst researchers who aim to produce tangible outcomes in the form of artefacts (Hevner et al. 2004). The robustness of design science research over other approaches as an IS research framework has been demonstrated by Hevner et al. (2004), and Hevner (2007) in the form of three research cycles namely the relevance, design and rigor cycles (Fig. 3.3); and design evaluation methods (Table 3.2).

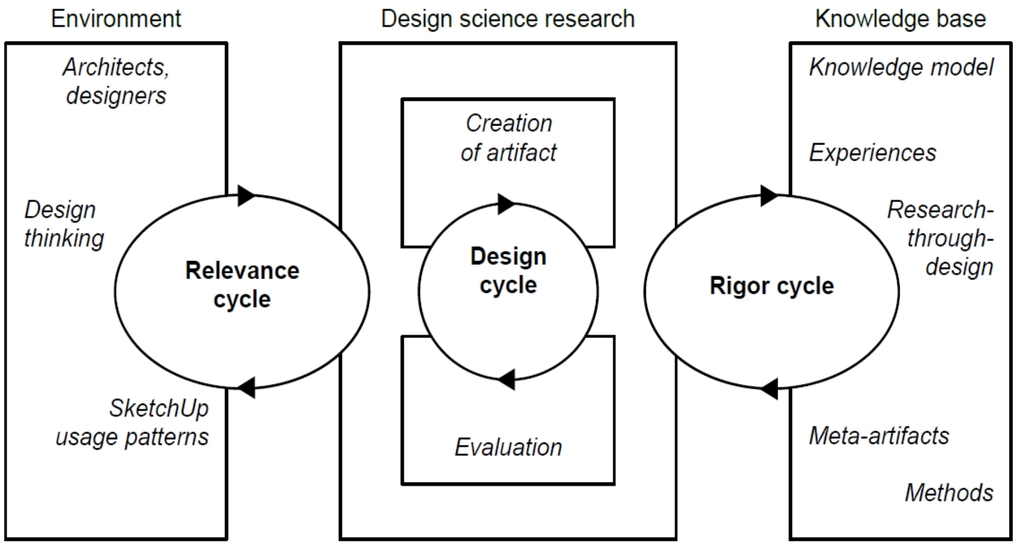


Figure 3.3: Design-science research methodology (Hevner 2007; Hevner & Chatterjee 2010)

The relevance cycle demonstrates the significance of the problem to stakeholders within the environment where the problem arose and from which the artefact to be developed would be used. The rigour cycle validates the theories, methods, the design process, and the meta-artefacts against a knowledge base to establish a solid philosophical foundation for the use of DSR. The relevance and rigour cycles are complemented by design cycle there is an iteration of the design and evaluation of the artefact. According to Hevner et al. (2004) the artefact from DSR must be evaluated for quality, effectiveness and usefulness through carefully planned methods. They classified the evaluation methods in DSR into five with (Table 3.2).

The list of evaluation methods and techniques listed in Table 3.2 are by no means exhaustive as more detailed IS artefact evaluation methods have been proposed by Prat et al. (2014) and Kangas (2016).

Table 3.2: Design Sceince Evaluation Methods and Techniques applied in this research

Evalution methods	Techniques	Application in this research
1. Observational	Case Study: Study artifact in depth in business environment	Illustrative case studies by expert reviewers to demonstrate utility of artefact
	Field Study: Monitor use of artifact in multiple projects	Partly – through the different illustrative case studies by the intervieewees and expert reviewers
2. Analytical	Static Analysis: Examine structure of artifact for static qualities (e.g. complexity)	Used at different stages in evlauting the models and artefacts
	Architecture Analysis: Study fit of artifact into technical IS architecture	Used to assess how the artefact fit into current database structure and interface design of IS/IT systems
	Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behaviour	Optimised the artifact to enahcne it performance
	Dynamic Analysis: Study artifact in use for dynamic qualities (e.g. performance)	Through iterative evaluation of the artefacts at the different layers of the semiotic ladder
3. Experimental	Controlled Experiment: Study artifact in controlled environment for qualities (e.g. usability)	Partly – proxies
	Simulation - Execute artifact with artificial data	N/A
4. Testing	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects	N/A
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g. execution paths) in the artifact implementation	N/A
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g. relevant research) to build a convincing argument for the artifact's utility	Internal eveualitio of the models and artefact based on findings, limitations and
	Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility	Used to evelaute the utiltiy of the artefact

(Hevner et al. 2004).

According to Prat et al (2014), DSR artefacts should be evaluated for how well it achieves its goal using three criteria namely efficacy or desired effect (Venable et al. 2012; Hevner et al. 2004); validity or working correctly (Gregor & Hevner 2013; Straub et al. 2004); and generality or achieving the broader goals (Aier & Fischer 2011; March & Smith 1995). The evaluation of DSR artefact against the environment (Prat et al. 2014) should address how well it meets the expectations of people, organization, and technology (Hevner et al. 2004). The main criteria should be consistency (Sonnenberg & vom Brocke 2012) in terms of utility, understandability (March & Smith 1995), degree of best fit (Wang & Wang 2010) and side effects (March & Smith 1995).

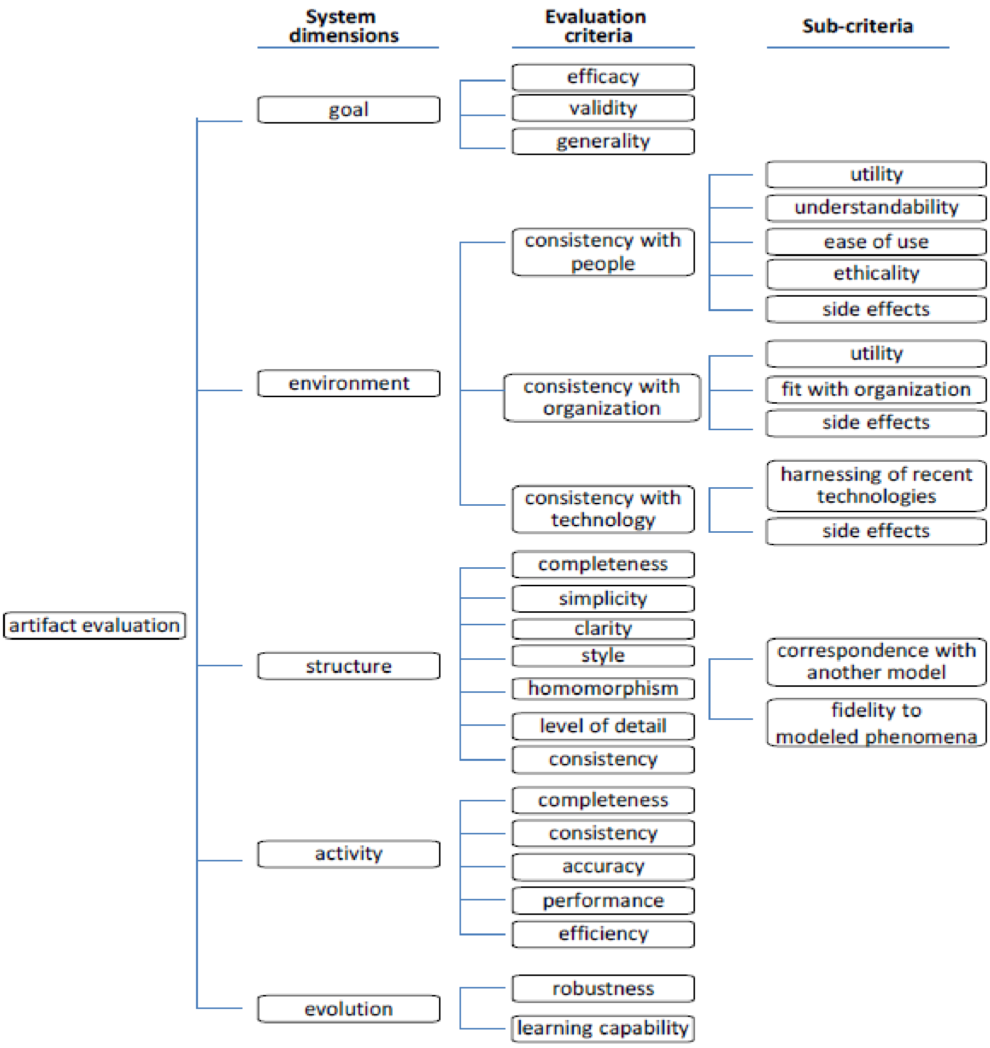


Figure 3.4: Hierarchy of criteria for IS artefact evaluation (Prat et al. 2014; Kangas 2016)

Furthermore, DSR artefacts may be evaluated for structure in terms of simplicity and completeness (March & Smith 1995), and level of detail (Prat et al. 2014); whilst assessment for activity should address issues on accuracy (Aier & Fischer 2011), performance (Hevner et al. 2004), efficiency and functionality (Hevner et al. 2004). Another assessment of DSR proposed by Prat et al (2014) is evolution in terms of sturdiness and learning ability (March & Smith 1995). In this study, the final artefact was evaluated for validity, applicability and utility (Prat et al. 2014; Kangas 2016).

Furthermore, design science research is guided by a set of seven criteria (Table 3.3) which helps to ensure robustness, validity, utility and rigour. The DSR criteria posit that an artefact should address relevant technology-based problem of which the contributions must be verifiable and communicated effectively to both technology and management audiences. The design of the artefact must be pursued as an iterative process of developing and evaluating the solution to meet the rigour required in IS research (Hevner et al. 2004).

Table 3.3: Design Science Research Criteria

Criteria	Description	Application in the study
1. Design as an Artefact	Design research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.	Series of models and artefacts produced at different stages
2. Problem Relevance	The object of design research is to develop technology-based solutions to important and relevant business problems.	Demonstrated through literature review and preliminary study to highlight problem
3. Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation plans.	Evaluation is consistently carried out to assess the models and artefacts developed
4. Research Contributions	Effective design research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, or design methodologies.	Contributions of the artefact to practice and implications were clearly outlined
5. Research Rigor	Design research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.	The pragmatism designed science used allowed for mixed methods to be applied in this study
6. Design as a Search Process	The search for an effective artefact requires utilizing available means to reach desired ends during satisfying laws in the problem environment.	The design of the artefact achieve through iterations of problem, models, design, and evaluate
7. Communication of Research	Design research must be presented effectively both to technology oriented as well as management-oriented audiences.	Parts of the outputs of this research has been communicated through conference, seminars, workshops

(Hevner et al. 2004)

This study follows the problem oriented IS research paradigm (Niehaves 2007) which draws on two complementary paradigms namely the behavioural science and design science research (Hevner et al. 2004; March & Smith 1995) as shown in Fig. 3.5.

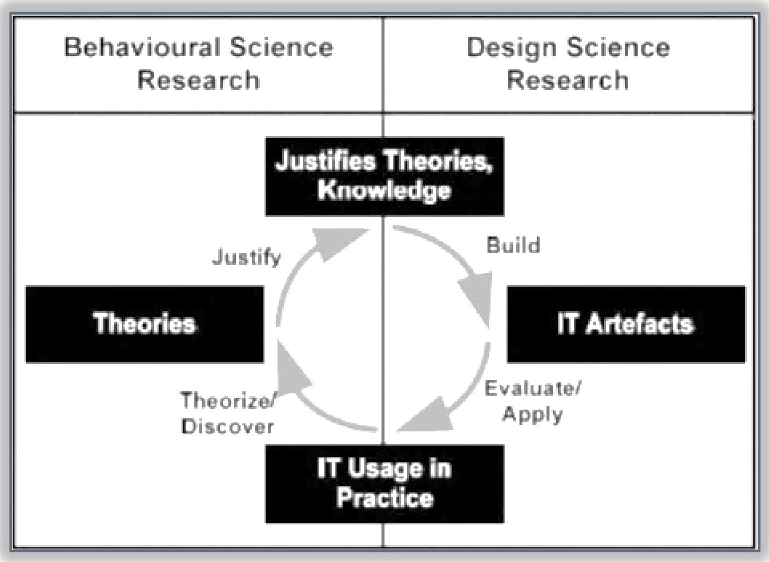


Figure 3.5: Problem Oriented IS Research cycle (Niehaves & Stahl 2006; Österle et al. 2011)

In information systems, technology and behaviour is inseparable (Lee 2000). Behavioural science research in IS, which is deeply rooted in natural science research focuses on developing theories related to human behaviour in IS. The aim is usually to understand the problem, hence the name problem understanding paradigm (March & Smith 1995; Hevner et al. 2004). Besides understanding the problem is the need to solve it, which lies outside the remit of behavioural science research and hence the complementary paradigm, design science research paradigm (Niehaves 2007). This paradigm is deeply rooted in engineering science and aims at solving a problem by building real IT artefacts for used in practice (March & Smith 1995). These complimentary paradigms allows for practical application or IT usage (artefact) after the justification of the truth or knowledge by theory (Hevner et al. 2004).

This study aligns well with the problem oriented IS research paradigms which follows the behavioural and design science research paradigms (Österle et al. 2011). The main research question for this study was "why are there misconceptions about the true value of knowledge derived from information stored in IS/IT systems"? The aim therefore was to explore the sources of missing context in stored data in IT systems and whether culture influences data storage and information retrieval from IS. The aim and objectives of the study formed the problem-understanding phase of the study. These were explored through critical review of literature, and preliminary case studies and survey.

Using the semiotic framework as a guide, data stored in IS/IT systems was considered as a "sign" which emanates from the happenings in the social environment. Human beings are involved in the creation, representation (syntactic), and retrieval of the "sign" in the IS/IT systems for information (semantic) and knowledge (pragmatics) activities. Consequently, the cultural orientations of the human user are assumed to influence the information object in several ways hence one of the objectives of the study was to ascertain how culture influences data storage and information retrieval from IS/IT systems. This demonstrates the close relationship between human behaviour and technology (Lee 2000) and therefore akin to behavioural science research paradigm. This phase of the study leads to the development of an artefact in the form of a human information interface model, which is in line with the suggestion phase of the design science research process adopted for this study.

Another aspect of this study deeply rooted in the design science research (Niehaves & Stahl 2006; Österle et al. 2011) is the development of an improved artefact in the form of a human information interface framework. This was to achieve the objective of how more context can be built into the data and information interface of IS/IT systems. The framework details an approach to the design of IS/IT interfaces to incorporate more context so that at the point of retrieving and using the stored data for information and knowledge activities, there will be availability of adequate context to enable context-specific information and knowledge activities. In order to demonstrate utility of the IT artefact (Niehaves & Stahl 2006; Österle et al. 2011); the HII framework was critically evaluated first through quantitative survey where the relationship between context-based data and information were ascertained through structural equation modelling. This was followed by qualitative (Maxwell 2005; Rogers et al. 2011; Saunders et al. 2009) interviews with select experts with experience in data, information modelling, business analytics and intelligence and data science. This study therefore adopted both the behavioural science and design science research within pragmatism paradigm.

The use of the design science paradigm is largely because it is used to produce artefacts such as models and constructs and methods (March & Smith 1995) which this study seeks to do. It is synonymous with the IT platform in the semiotic ladder proposed by Stamper (1973). It relates to the physical representation (syntactic, empirics and the physical world) of the IS which technically represent the artefacts of the IS. On the other hand, the relevance of the behavioural science paradigm to this study is because the researcher seeks to understand the human information interactions processes in order to develop a model for improving the data and information interface design of computer-based IS. The behavioural science paradigm has been used in socio-technical studies especially in human-computer interaction (Henver et al. 2004). And since this study focuses more on the top three layers or the human information functions of Stamper' (1973) semiotic ladder, the researcher finds the behavioural science paradigms very applicable to this study.

3.4 Research Strategy

The choice of research strategies to use is tied to the type of research being conducted (Saunders et al. 2009). Then the research design, methods and approach are chosen to match the research need (Creswell 2009). According to Saunders et al. (2009), purpose of management is usually descriptive, exploratory or explanatory. Gregor (2006) contends that IS researches are primarily aimed to analyse, predict, describe and design. The purpose of this research is one of explanatory and subsequent design of an artefact. The following sub-section discusses the general research strategy used for the study.

The strategy adopted for the study can be divided into four phases. The awareness of the problem is highlighted through experience of working as a consultant data analyst and IS developer, and from critical literature analysis. Then from preliminary case studies and survey, a conceptual model is suggested. This is then refined based on feedback from conference and seminars where the model was presented; and a framework is developed and evaluated.

3.4.1 Practiced-based Experience and Critical Literature Survey

The first phase of the research is the awareness of the problem (Vaishnavi & Kuechler 2004) which was based on the experiences of the researcher from working as a Consultant Data Analyst Specialist, Information Specialist and IS and software development consultant in Ghana for close to a decade. From these roles, the researcher recounts countless occasion where he had to apply his own knowledge to available data especially whilst working as a Data Analyst, in order to understand and make meaning of the data. The realisation was that there is missing context information in stored data in the IS/IT systems.

A critical review of literature on HCI and IS design, knowledge management, knowledge activities, data, information and knowledge (DIK), context and quality issues in DIK was carried out to provide evidence of literature of the problem. This allowed for the problem statement to be conceptualised as universal whilst exploring its evidence within several contexts through case studies. In addition, key theories such as semiotics, and activity theory were reviewed to provide established anchor for the study. The literature was sourced from research reports; scholarly articles in science and management; among others. The study thus has interdisciplinary background drawing on scholarship from several disciplines including but not limited to information science, business informatics, psychology computer science, data science and management.

3.4.2 Development of the Conceptual Model

The second phase of the research was the development of the conceptual framework from the a preliminary study. This preliminary study was meant to show empirical evidence of the problem statement in support of activities in phase 1, and the results formed the basis for proposing the conceptual model. This aligned with the "suggestion" stage of the design science process (Vaishnavi & Kuechler 2004). Part of the results from the preliminary study was presented at a conference, and seminars; and the constructive feedback received formed the basis for developing the actual HII framework.

3.4.3 Development of the Framework

The third phase of the research was the development of the HII framework. The HII framework represent an approach to build more context in the data, information and knowledge interfaces in IS/IT systems. It consists of the components of the semiotic framework as a proxy for representing data storage in IS/IT systems; which we conceptualised as representing HCI (syntactic). The semantic part is concerned with establishing meaning (information) of the stored data, which we conceptualised and defined as HII. In addition, human knowledge interface (HKI) was conceptualised and defined to represent the pragmatic layer where the focus is on application and utilisation of information for knowledge activities. The framework postulates an approach for building more context into the data, information and knowledge interface in IS/IT systems to enhance the quality of knowledge activities.

3.4.4 Evaluation of the HII Framework

The fourth phase of the research involved the evaluation of the HII framework using case studies. The aim was to provide empirical evidence of applicability of the framework in the form of proof concept of how the framework might work in real life situations. Qualitative interviews and experiments were conducted for the purpose of testing how the potential human information interface design might look like. These evaluations were meant to ascertain whether the framework can potentially help improve on the quality of knowledge activities based on the proposed data, information and knowledge interface for IS/IT systems.

3.5 Research Design

Based on the research philosophy and strategy (see sections 3.2 and 3.4 respectively), the pragmatism design science research design was deemed the most suitable to use for this study. According to Venable (2006) pragmatism design science is guided by research goals and allows for the use of multiple methods (Creswell 2009; Goldkuhl 2012; Hevner 2007; Saunders et al. 2009) that leads to the development of constructs or artefacts, effective evaluation of results for reliability, utility and validity.

The overarching question that this study seeks to answer is: Why are there misconceptions about the true value of knowledge derived from stored data and information in IS/IT systems? Consequently, the main outcome of this research is to: develop a HII framework that builds context in the interface of IS/IT systems to improve the quality of knowledge activities. In order to achieve this aim, the study was designed to highlight the source of the research problem as coming from the environment (social world) when IS/IT systems are used to capture data (syntactic) and for information (semantic) and knowledge (pragmatics) activities. The entire research design is summarised in Fig. 3.6.

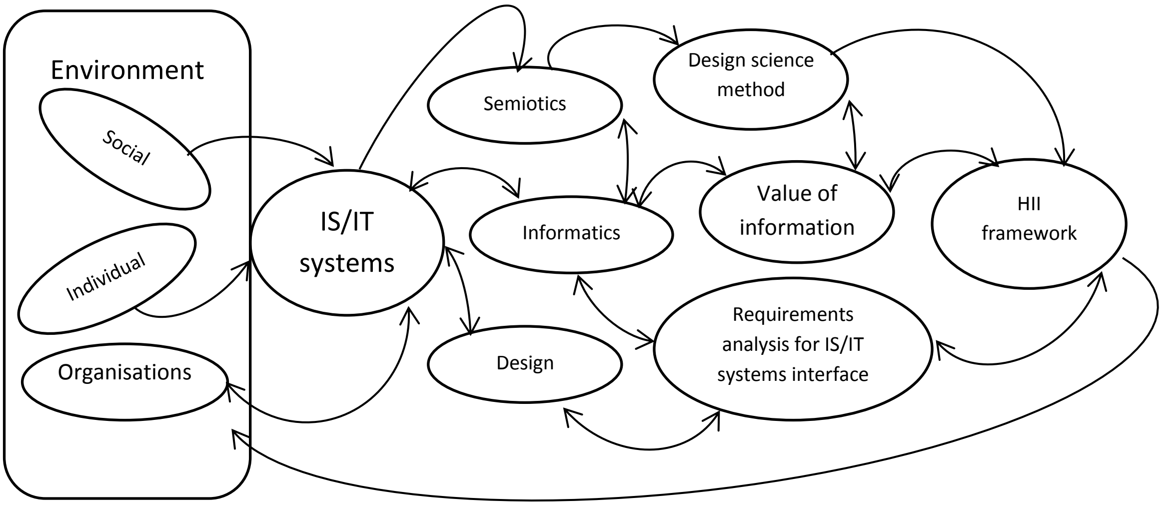


Figure 3.6: The Research Design

The entire research design is an interconnection of semiotics, IS/IT systems, design science, informatics, IS interface design and the approaches to data storage and information retrieval (Fig. 3.6). Data is perceived as a multidimensional construct which must be stored in its entirety as a "sign" in IS/IT systems to provide adequate context for its subsequent use for information and knowledge activities. The semiotics origin of the problem is that even though data (context – why, who, what, how, when, where, and situation) originates from, and impact on the environment, when it is being stored in IS/IT systems, the nature of the current interfaces together with the database backbone only allows for the "what" components of the data to be stored. This means the true value of knowledge derived from stored data is questionable, as users have to apply their own knowledge to create a context for the data when they engaged in information and knowledge activities. This represent the human behaviour aspect of interaction with data in IS/IT systems. The research problem is thus synonymous with the IT platform and human information functions of the semiotic framework (Liu 2000; Stamper 1973). Using the pragmatism design science research (Hevner 2007) allowed for the integration of theory, human activities, culture, people, IS/IT systems, design methods to produce an artefact (Opoku-Anokye 2014; Liu 2000; Stamper 1973; Beynon-Davies 2002).

The study utilised the behaviour science and design science research designs to contribute to an artefact relevant and applicable to the design of IS and the behaviour of the users of the artefact in a social context. Also, the use of semiotics framework and IS design theories such as systems analysis and design offered a practical application of theory in real situation and thus helps bridge the gap between theory and practice. The study was inspired by semiotics (Stamper 1973; Liu 2000), and the semiotic framework was used for the problem analysis; design of the HII framework as well as for evaluative purposes.

The Informatics discipline helped evaluate the "value" aspect of information and knowledge derived from stored data in IS/IT systems. The design science and requirement analysis for IS/IT system interface design component provided IS tools and methodologies for the design of both the interface for the IS/IT systems and the multidimensional databases to allow adequate representation of context to support information and knowledge activities when data is retrieved. The artefact in the form of the HII framework is fed back into the environment and evaluated for utility, acceptability and validity against the research problem; and possibly kick start the design science research cycle again (where necessary).

The HII framework contributes three artefacts to IS systems design. These include constructs and metrics for assessing the quality of human information interactions; enhanced approach to the design of context-based data and information interfaces into IS/IT system; and a method to enhance the scope of the requirement analysis to support the design of multimodal interfaces and multidimensional databases to support IS/IT systems.

3.6 Research Approach

The logical reasoning behind a research enquiry is known as research approach. Literature identifies three research approaches namely induction, deductive and abductive (Hyde 2000; Josephson & Josephson 1996). The deductive research approach, also called the top-down approach, is a research where the logical reasoning starts from a more generic outlook to a more specific item. The approach deductive approach usually begins with a theory about the research area. This subsequently narrowed down into specific propositions and tested. The steps use theory, make propositions, collect and analyse data to address the propositions, and confirm or to refute the original theories (Hyde 2000). On the other hand, the inductive research approach, also called the bottom-up approach, starts with specific observations and then broadens out to generalisations. The steps involve include starting with specific observations and measures, patterns recognition, formulation of tentative propositions, and exploring these tentative propositions to develop general conclusions or theories (Hyde 2000).

Abduction, according to Josephson & Josephson (1996), is the logical approach to research whereby illustrative propositions are made and accepted. They described it as a theory forming or inference approach that starts from describing data (i.e. facts, observations, etc); to propositions, that best explains the data. Abduction, according to Thagard (2007), is simply a kind of induction, in which the generation of explanatory propositions is based on uncertainty.

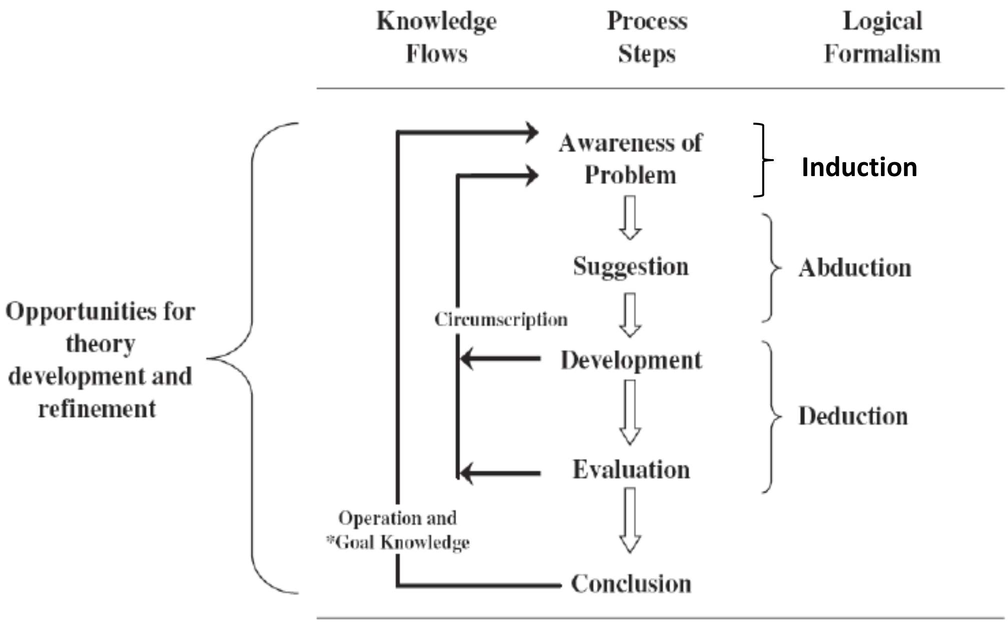


Figure 3.7: Logical Reasoning in Design Science Research (Vaishnavi & Kuechler 2007)

The logical reasoning applied in this study based on Vaishnavi & Kuechler (2004) is shown in Fig. 3.7. This illustrates the five-step design science research process, the logical reasoning in achieving the research aim as well as the knowledge flows throughout the entire research process. A summary of how all three approaches of induction, deduction and abduction were utilised to achieve the research objectives is shown in Table 3.4.

Table 3.4: Study objectives and the approaches used

Study Objectives	Evidence	Approach
1) What are the sources of missing context and information gaps in stored information in computer-based systems?	Literature (Dey 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa, 2004, Dzandu & Tang 2015, etc), and data from survey & interviews	Induction, deduction and abduction
2) How does culture influence data storage and information retrieval for knowledge activities	Literature (Schmidt 2000; Rosenbloom & Larsen 2003; Dey 2001); & data from survey and interviews	Induction, deduction
3) How can more contexts be built into the data interface to enhance the quality of knowledge activities?	Literature review, proposed multi-dimensional approach to data storage and data from survey & interviews	Induction, deduction and abduction
4) How can more context be built into the information interface to enhance the usability of information for knowledge activities	Literature review, proposed multi-dimensional approach to data storage and data from survey & interviews	Induction, deduction and abduction
5) to what extent does an improved information interface design impact on the quality of knowledge activity?	to be based on survey experiment, interviews during the validation of the model	Deduction Induction abduction

3.7 Research Process

This study follows a typical IS research approach (Hevner et al. 2004; Niehaves & Stahl 2006), using the design science process (Vaishnavi & Kuechler 2004), against the design science research cycle (Hevner 2007) and the design science criteria of Hevner (2004) to achieve the aims and objectives of the study. The entire research process for the study together with how rigor is ensured within the environment is shown in Fig. 3.8.

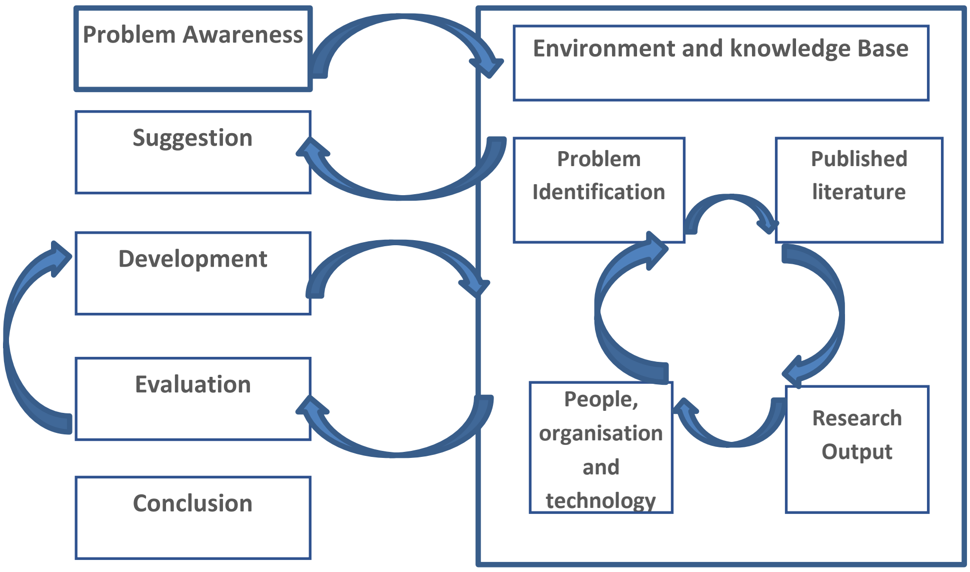


Figure 3.8: Research Process with Rigour Cycle
(adapted from Hevner 2007; Vaishnavi & Kuechler 2004).

Design science process begins with problem identification and relevance (Vaishnavi & Kuechler 2004; Hevner et al. 2004; Baskerville et al. 2009); suggestions (Takeda et al. 1990), and then the development and evaluation cycles leading to an innovation in the form of artefact (Hevner 2007; Vaishnavi & Kuechler 2004; Vaishnavi 2008). The next section discusses how the steps and rigor cycles were applied to this study.

3.7.1 Awareness of the Problem

Problem awareness is the first step in a research process, and it helps to explicitly outline the research aim, objectives and the research outputs. The problem awareness of this study comes in two folds – from literature and practical experience. The first awareness of the problem was during the researcher's working experience as Consultant Data Analysis Specialist and software developer for various local and international institutions in Ghana and in the UK. On many occasions during working with clients, the researcher realised that the data he must work on lacks several context information to make for easy understanding.

Similarly, from the software development projects, it was realised that the current design of databases and existing HCI interfaces can only store the sign about an object or person (syntactic representation). These results in lack of context information associated with stored data; and this means that users must apply their own knowledge to the data/information to understand it and to engage in information (semantic) and knowledge activities (pragmatic) in a given social environment. However, as often is the case, the assumed context might not match the original context, leaving behind instances of context deficiencies, which affect the quality of knowledge activities. As a result, decisions, planning, strategies and those other knowledge activities based on stored data that lack adequate context information is questionable. The problem of lack of context is significant and relevant not only to businesses but to the larger society (Hevner et al. 2004) more so given that the entire world today is driven in one way or the other by IS/IT systems with stored data.

Also, whilst working as an e-Learning content developer and e-Learning facilitator on Statistics in Applied Climatology course at the Statistical Services Centre, University of Reading, the problem of context deficiencies became even more evident as the course content sails through the content expert, through the developer, tester and through the facilitator to the participants. This experience served provided an opportunity to conduct the preliminary study to demonstrate empirical evidence of the research problem whilst helping to develop the conceptual model for the study.

Furthermore, through critical review of literature (Vaishnavi 2008) from IS, computer science, information science, management and psychology among others, considerable evidence of the research problem was established. Based on the nature of the research problem, the aim is to produce an artefact as a research output, a key criterion in design science research (Carlsson 2005, 2006) and hence the choice of design science as the research paradigm. The HII framework would serve as an artefact to build more context into data and information interfaces for improved knowledge activities from stored data in IS/IT systems.

The choice of design science paradigm for the study over other research paradigms is informed by the systematic approach, demonstration of the research relevance, the criteria and rigor (Hevner et al. 2004) that underpins design science. The design of an artefact in the form of the HII framework meets the suggestions by Järvinen (2007) that design science research output should be either a completely new artefact or offer value in the innovation.

The value of this research lies in the approach to the design of interfaces for IS/IT systems where adequate context can be built into the data/information interfaces so that users can engage in context specific information and knowledge activities. IS/IT systems have focused very much on using signs to capture phenomenon, that is through data representation. This has been largely achieved through HCI, which somewhat represents the syntactic level of the semiotic framework. The current design of IS/IT systems do not allow adequate context to be captured with the data. The users of the stored data are thus left to apply their own knowledge or context to the data to understand it, create information or engage in knowledge activities. The assumed context might not match the original context of the data when it was created. Context is thus treated as an after taught of stored data in IS/IT systems, a situation akin to inadequacies in the requirement analysis for the design of interfaces. The awareness of the problem is comprehensively captured in chapters one and two.

3.7.2 Suggestion

The suggestion phase of the design science process involves proposing an initial artefact or a conceptual model based on the awareness of the problem. Through various processes, including practical experience to begin the problem awareness, literature survey to establish evidence of the literature of the problem and identify the appropriate methodologies and methods necessary to design an effective solution to the research problem. Design science research entails the use of rigorous methods to design the artefacts (Hevner et al. 2004). The suggestion phase of this study therefore involves the review of methods to accomplish the task of developing an HII framework.

3.7.3 Development

The aim of the design science research is to develop an artefact through iterative processes including conceptual model, and then the first real artefact at the data level, then subsequent ones at the information and knowledge levels leading to achieving a best-fit solution to the research problem (Hevner et al. 2004). The review of methods of interface design and models of integrating new components into established systems are undertaken in the light of the findings from the case studies. The outcome of these was the identification of key components of missing context of data stored in IS/IT systems considered as limitations of current IS/IT systems and human efforts.

Considerations of integrating those key components of missing context of data stored in IS/IT systems are perused at the various levels of the semiotic ladder. The integration of the identified components of missing context of data (social environment factors) stored into IS/IT systems at the data interface (syntactic level); information interface (semantic level) and knowledge interface (pragmatic level), results in the HII framework for knowledge activities.

The HII framework posit that if the identified components of missing context of data is integrated with the sign at the point of capturing into IS/IT systems, and these contexts become available to users. Therefore, when data/information is retrieved from IS/IT system users do not have to rely on their assumed knowledge to create and engage in context specific information and knowledge activities.

The framework assumes that the phenomenon represented by the sign in an IS/IT system emanates from the social environment and as such should reflect adequate context about the data. These should include "what" the sign is about, the "how", the "when", the "where" and "why" of the data. This also presupposes that current interface and database design would require a shift from one-dimensional structure to dynamic or multi-modal interfaces and databases capable of adequate context information at the data/information interfaces. The development phase in this study extends from the suggestion phase in chapter four and refinement of the HII framework as reported in chapters five. This next stage of the process is evaluation of the artefact.

3.7.4 Evaluation

One of characteristics of the design science approach is rigor. Validation of the effectiveness of the artefact requires acceptance within the relevant community of academic and practitioners to be true in solving the research problem (Hevner et al. 2004). The evaluation of this research involved different stakeholders from various backgrounds and industries. Given the general nature of the research problem, since individuals, groups of people and the larger society interact with IS/IT systems on virtually daily basis, potentially anyone who uses, have used or will used data stored in some IS/IT systems for information and knowledge activities is a beneficiary of the outcome of the research. Since it was not possible to design and implement the HII framework during the life of this research, hypothetical cases were used in the form of experiment, survey and interviews, to provide empirical evidence of proof of concept to validate the framework. Through iterative process, from literature, interviews (both informal and formal), feedback from seminars, workshop and conferences, the framework has been evaluated to ensure that the artefact addresses the research problem and achieves the aim and objectives of the study as set out in chapter one. Chapter seven of this thesis covers the evaluation.

3.7.5 Conclusion

The conclusion phase of the design science process allows for a reflection on the entire research from the problem statement, the design of the research, processes involved in collecting data through to the research outcomes. The conclusion also includes a re-statement of the research contributions based on the research outcomes. The limitations of the study are also assessed based on potential implication of the research outcomes to theory and practice; and suggestions for future research directions are outlined. A key feature of the design science research process is communication of the research outputs to either academic or practitioner communities or both. Related research papers that have been published during the research journey and those future planned publications based on the research outcomes are highlighted. The conclusion of this thesis has been reported as chapter eight.

3.8 Methods and Tools of Data Collection

The study adopted a pragmatic epistemology and utilised multiple data collection instruments and data sources to provide evidence for the study. This section discusses the data collection methods used, the justification for the choice of these instruments; and how the methods used helped to collect data and achieve the research objectives. Data analysis and management including archiving plans are discussed including ethical considerations.

3.8.1 Survey

A survey method was used to generate quantitative data at different stages of this research. Survey research method involves the collection of data from a large sample, and the generalisation of the findings to represent the whole population (Hair et al. 2009). Survey research method are best suited for studies where the research questions are “what”, “who”, “how much”, “where” and “how many”

(Saunders et al. 2009). It is used to test propositions or existing theory and follows the deductive approach. The approach is usually made up of 5-steps namely -develop propositions, operationalise propositions, test the operationalised propositions, examine the findings, and refine the theory based on the findings (Saunders et al. 2009).

The survey approach was used to collect data at two stages of the study, the initial exploratory study on the human information interaction with computer-based information systems. Although survey method has the advantage of rapid turnaround and generating large volumes of data, it has weaknesses in terms of fixed and rigid response set and sometimes, high incomplete responses. These weaknesses were compensated for by the strengths of the other data collection methods such as case studies and experiment.

3.8.2 Case Study

The case study research approach involves empirical data collection on contemporary phenomenon within its real-life context using multiple sources of evidence (Yin 2003). The multiple sources of evidence popularly used in case studies include interviews (Saunders et al. 2009), documentations, archival records, observations and physical artefacts (Yin 2014). Davey (1991) identifies six types of case studies namely exploratory, cumulative case, illustrative, program implementation, program effects and critical instance studies. In addition to these, Yin (2009) categorised case study strategies as holistic, single, multiple cases, or embedded cases whilst Seale (2011) classified case studies either as revelatory, representative, critical or unique case studies.

This research used a mix of exploratory, illustrative (Davey 1991), and representative case studies (Seale 2011) with the multiple case studies strategy (Yin 2009) to investigates the problem of missing context in stored data/information in IS/IT systems. In addition, case studies were used to evaluate the HII framework to demonstrate applicability and utility. These made it possible to carry out multiple case studies for considerable evaluation of the framework across multiple industries, organisations and instances. Therefore, the advantages of case studies, which include in-depth and real-life context of enquiry about a problem, were fully utilised. The strengths of case studies complimented the weaknesses of the survey methods to enhance the rigour and robustness of the entire research methodology.

3.8.3 Instrumentation

The instruments used for this study are questionnaires (Rogers et al. 2011; Myers 2009), interview protocol and experiment. The choice of questionnaire as one of the data collection instruments was informed by it is worldwide acceptance, rapid turn-around, large reach, and economical (Rogers et al. 2011; Myers 2009) compared to interviews, and observations. Although Rule et al. (2011) pointed out some disadvantages of questionnaires as lack of control over the data-exchange process and inability to probe for further details, the questionnaire was still preferred.

3.8.4 Interviews

Interviews (Saunders et al. 2009) were also used to collect data for the main part of the research and for the evaluation. The choice of the interview method was informed by the advantages it offers in terms of depth, flexibility, and ability to uncover human feelings and experiences (Oates 2006). The interview protocols were made up of semi-structured (Oates 2006; Rogers et al. 2011) and covered the key issues of context, interfaces, data and information in IS/IT systems and how interfaces impact on knowledge activities (see Appendix 5 and 7). Some relevant issues and questions, however, emerged during the conduct of the interviews. Meyers and Newman (2007) justified the use of qualitative interview in IS research.

3.8.5 Data Analysis and Management

Different data analysis techniques and tools were applied to the data generated for the study in line with the types of data, that is whether exclusively qualitative or quantitative (Saunders et al. 2009; Maxwell 2005) or whether it was semi-structure or a mixed of qualitative and quantitative. For the preliminary study on understanding human information interaction on an eLearning platform; a mixed of descriptive statistics and thematic content analysis were used since the data collection instrument (see Appendix 3) was a questionnaire with both closed ended and open-ended questions (Oates 2006; Rogers et al. 2011).

The validation of the model and the evaluation of the framework were achieved through quantitative survey and the use of partial least squares structural equation modelling (PLS-SEM) for testing and confirming the propositions (Gefan et al. 2000) as to whether improved data and information interface had significant positive effect on knowledge activities. The use of SEM was informed by its numerous benefits which among others include evaluating hypotheses, confirming theoretical models, detect hidden relationships (Bagozzi & Yi 2012), identify complex structures such as mediation and second order analysis and moderation (Hoyle 1995).

The robustness of SEM is evidenced in a six-step approach proposed by Hair et al. (2009, 2017) as follows:

Step 1 – The first stage of SEM involves defining the constructs and individual variables to be used in the modelling. These include a clear identification of the dependent, independent, and intervening variables (in this case the mediators). The constructs and corresponding variables can be adopted from existing literature, could be adopted from existing theories, models or framework and adapted within the same discipline or to/from other disciplines. Where there are no prior studies, the constructs and variables can be developed from the literature. The variables for the constructs are then defined as measurable items using Likert scale (Hair et al. 2009; Oates 2006; Olivier 2004; Zikmund et al. 2013).

For this study, the key constructs were data quality (Wang & Strong 1996; Karimi et al. 2004; Ravichandran & Rai 1999); information quality (Chang & King 2005); knowledge quality (Sasidharan et al. 2012; Wang & Strong 1996); quality of knowledge activities (Matusik & Heeley 2005; Lai & Lee 2007; Beesley & Cooper 2008; Sowe et al. 2008; Lew & Yuen 2014; Lew et al. 2013). Also, a variation of Hofstede cultural orientation, called the CV scale was adopted and adapted to IS with respect to data storage and information from IS/IT systems whilst context-based data and context-based information constructs were developed from extant literature (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; and Sowa 2003). Another set of constructs developed from literature was the human information interface factors (Marchionini 2008; Stamper 1996; Barron et al. 1999; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006).

Step 2 – Specify measurement model

The factor analysis technique is the commonly used measurement (Olivier 2004; Oates 2006; Zikmund et al. 2013) model in SEM. It is useful for grouping items or variables under defined constructs, for confirming the reliability of each constructs (Hair et al. 2009) whilst helping to decide which of the items or variables should be used for further analysis (Blunch 2013; Hair et al. 2009, 2017). The three factor analysis techniques often used to develop measurement (Olivier 2004; Oates 2006; Zikmund et al. 2013) models are exploratory factor analysis, confirmatory factor analysis and principal component analysis (Blunch 2013). For this study, exploratory factor analysis was used for the SEM.

At this stage too, the development of path diagram using relevant SEM notation is considered. The indicators namely exogenous (influencing variable) and endogenous (influenced variable), together with the error terms are used to depict the SEM relationship between the constructs/variables. The SEM relationship usually includes the measurement (loading) where the relationship between the items and the latent variables, the structural relationship in the form of a path diagram and correlational in the form of a bi-directional arrow to show that two constructs are correlated (Hair et al. 2009, 2017). An example is shown in Fig. 3.9 where comp_1, 2 &3 are items that form the latent variable (exogenous variable – e.g. COMP, LIKE) which in turn influences the endogenous variable (CUSL).

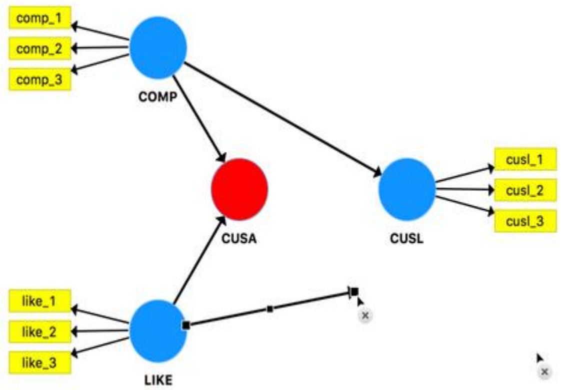


Figure 3.9: Sample Model Measurement (SmartPLS 2018)

Step 3 – Execute Study Design to Generate Empirical Data

This stage involves data pre-processing and methods for data cleaning, estimation techniques, ensuring data normality, sample size and model complexity; and handling of missing data. Sample size and model complexities are key factors for reliability and validity assessment. Although, Hair et al. (2009, 2017) recommends maximum sample sizes of 100, 150 and 300 for models with <=5; and <=7 with item communalities of >0.6, 0.50 and <0.45 respectively, Bagozzi and Yi (2012) contends that sample size larger than 200 is universally acceptable for SEM analysis.

There are two ways of handling missing data. The imputation method, where missing values are replaced with mean and complete case method, where the entire record is deleted for any missing value. For data normality; among the available techniques such as the Generalised Least Square (GLS) method of estimation (Hair et al. 2009, 2017), the Maximum Likelihood Estimation (MLE) is considered the most reliably in the level of estimation of a model independent of the normality of data (Bagozzi & Yi 2012; Gefan et al. 2000). However, given that data normality is not an issue when using SmartPLS (Ringle et al. 2015), these techniques were deemed to have been applied to the data by the PLS algorithm.

Step 4 – Assess measurement model validity

The measurement (Olivier 2004; Oates 2006; Zikmund et al. 2013) model validity is used to check for the validity of the individual and composite measures of the constructs using appropriate tests and indices. This include construct validity using outer loading and cross-loading;, discriminant validity using cross loading and Fornell-Larcker criterion; and convergent validity using the average variance extracted (Ab Hamid et al. 2017, Hair et al. 2017). The recommended threshold for validity for the indices used in this study are shown in Table 3.5)

Table 3.5: SEM Validity Test Thresholds

Indicators	Hair et al. (2017)
AVE	>0.50
VIF	< 5
Outer loadings	>0.70
Cross loadings	>0.50

Step 5 – Specify structural model

At this stage, all the relationships between the constructs defined in the measurement (Olivier 2004; Oates 2006; Zikmund et al. 2013) model (Step 2) and confirmed in the assessment of the measurement model (Step 4) are used to establish a structural model (Hair et al. 2009, 2017). The model reflects the propositions in terms of direction, level and order of constructs.

Step 6 – Assess Structural Model Validity

The validity of the structural model is assessed next for significance and direction of the relationships as well as model fitness. Depending on the validity coefficients, SEM allow the use of modification indices or additional correlation relationships (Hair et al. 2009, 2017); altering the direction or removing existing and adding new variables to structural relationships to improve the model.

For example, the direction of the proposition for the relationship between quality of knowledge activities and the context of data, context of information and interaction components can be altered and some items for these constructs can be removed or added on if data is available to improve the structural model validity.

3.8.5 Ethical Considerations

The researcher diligently followed the research ethics guidelines of the University of Reading specifically that of the School of Management. This was in line with the suggestion by Oates (2006) that most universities and research groups have committees and processes to assist researchers with ethical considerations. Care and adequate provision were made to eliminate any negative effect or consequences that the study can potentially have on any participant, group of people and organisations that was involved in one way or the other in this study (Mouton 2001). The consent of subjects was sought, and participants were always asked to provide informed consent before primary data was collected (Lazar et al. 2010). Moreover, it was ensured that no sensitive information is extracted from survey-takers and experiments participants.

The right of subjects and organisations to voluntarily participate and to withdraw from the study at any point in time was respected. Where organisational data and resources are used or made available to the researcher during the study, care was taken to ensure that data security, protection and fair use policies were not breached. In addition, anonymity and confidentiality of the respondents were strictly adhered to. At each data collection stage, the statement of anonymity and confidentiality was captured on the information sheet (see Appendix 1) and made available to respondents. This was meant to encourage respondents to provide accurate responses rather than desired responses (Zikmund et al. 2009). Extreme care and efforts went into avoiding plagiarism and misuse of data, as well as falsification of data or results among others.

The data collection exercises were only undertaken after the approval of the required submissions, which included a summary of the research proposal, informed consent and information sheet and completed ethical approval form. The ethically guidelines (Olivier 2004; Oates 2006) were adhered to strictly including notifying and signing off with the Administrator in the Informatics Research Centre/Business Informatics Systems and Accounting, when the data collection and the research was completed.

3.9 Chapter Summary

In this chapter, research philosophies and paradigms within the fields of IS research are discussed and compared to decide on the best and most appropriate to drive this study. Research philosophies and paradigms serve as a guide to judge the relevance, validity, acceptability and replicability of research outputs. This chapter therefore discusses and justifies the choice of pragmatism as the research philosophy and design science as the research paradigm. These informed the selection of the appropriate research approach, techniques, methods and process on how data was collected, analysed and presented to address the research aims and objectives.

The research aimed to developing a human information interface framework for knowledge activities. The choice of pragmatism design science methodology adopted for the study was discussed. In order to achieve the objectives of determining how culture affects data storage and information; and identify the sources of missing context in stored data in IS/IT systems; a mixed method (Venkatesh & Brown 2013) approach involved qualitative critical analysis of literature and quantitative Maxwell (2005) case studies is discussed. Following the design science research paradigm, the problem awareness phase was discussed within the context of behavioural science research method where the focus was on understanding and relevance of the research problem.

The use of the design science research paradigm to design artefacts in the form of a human information interface model and how this was refined into a human information framework was discussed. The design of the model and the framework, which represents the suggestion and development phases of the design science research process were discussed. The purpose was to address the research objectives on how more context could be built into the data and information interface in IS/IT systems.

This chapter also discussed how the artefact (HII framework) was evaluated for applicability; validity and relevance through mixed methods (Venkatesh & Brown 2013) of critical review, questionnaire survey (Rogers et al. 2011; Myers 2009) and experts interviews. The research methodology thus demonstrates relevance, rigour, and design (Avison and Elliot 2006; Hevner 2007) through the adoption of pragmatism philosophy and a behavioural and design science research design that followed a five-process step and a set of seven design science research criteria to produce an IT artefact (Hevner 2007; Cole et al. 2005).

A summary of the entire research design and methodology in relation to the chapters are shown in Fig. 3.10.

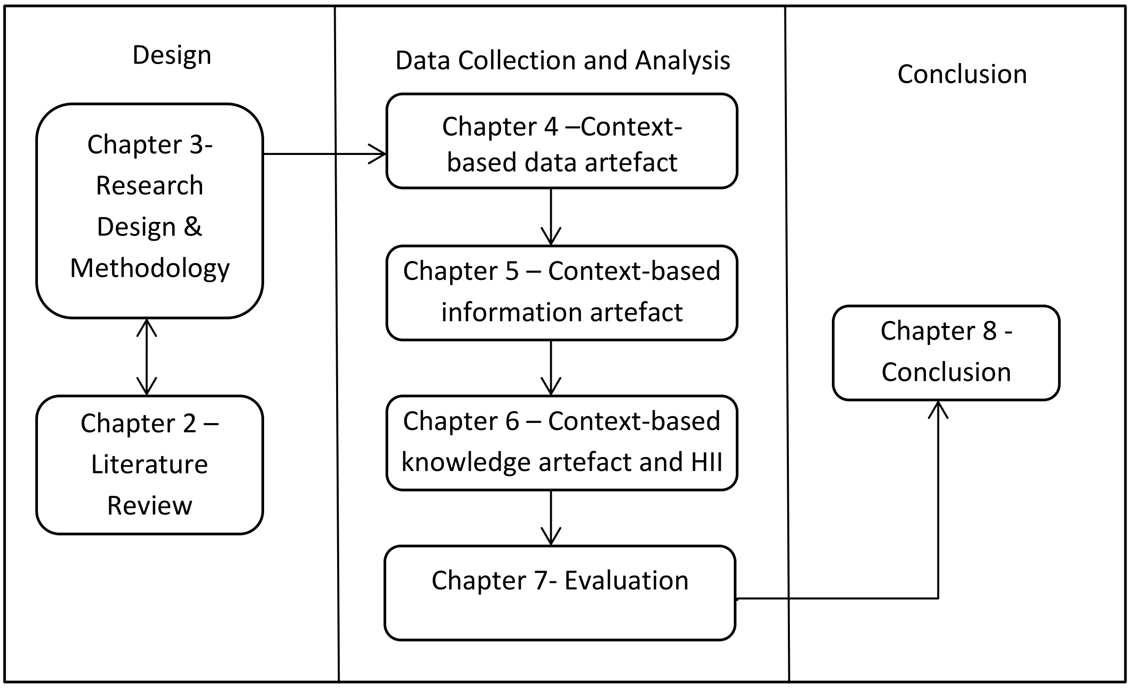


Figure 3.60: Research Design and Methodology

Chapter 4
Context-Based Data Interface Model

4.1 Introduction

In this chapter, a preliminary study is used to develop a conceptual framework, which then serves as a blueprint for developing the first iteration of the human information interface framework. The preliminary study serve as an exploratory attempt to establish empirical evidence of the research problem whilst addressing the first two key objectives of the study which are to 1) determine the sources of missing context and information gaps in stored information in computer-based systems? and 2) explore how culture influence data storage and retrieval from computer-based systems. The chapter is therefore organised in three parts, namely the preliminary study and conceptual model; development of the context-based data interface model through qualitative interviews; and the validation of the context-based model through quantitative methods using structural equation modelling.

4.2 Preliminary Study and Conceptual Model

This section contains the reports from a case study that seek to highlight the problem of the study; that is to establish evidence of missing context in stored information from the lack of or inadequate capture of context with stored data in information systems. In this two-stage study, the content of an eLearning course in Applied Statistics was used as a model of information system. Data was collected from participants at the end of the eLearning course and analysed using the semiotic framework as a guide to identify missing context, data and information gaps from their interactions with the eLearning course content. This was followed by interviews with the development team of the eLearning course.

4.2.1 Method Approach

Part of this case study has already been reported in Dzandu & Tang (2015). Using the semiotic framework as a guide, the existing eLearning course is evaluated with the view to proposing a model for designing improved eLearning contents for future eLearning programmes. The study follows the quantitative-qualitative model (Maxwell 2005). In the first part, a survey questionnaire (see Appendix 3) was used to collect data from 168 participants on the eLearning course in Statistics in Applied Climatology. The questionnaire was designed and mounted on Moodle, which is a learning management system platform. The subjects or the human actors were the participants on the eLearning course as well as the content development team, testers and facilitators. The semiotic framework was used as an analytical framework with the four key components namely syntactic, semantic, pragmatics and social world serving as the themes. The eLearning course was considered as being synonymous with an information system (IS) which deals with symbolic representation of reality (Liu 2000).

The questionnaire had mostly closed-ended questions and a few open-ended questions. The views of the participants were analysed with a focus on only their interactions with the content of the course and its related information. The completed questionnaires were first downloaded into Microsoft Excel. The data was then sorted, cleaned and coded before being imported in SPSS version 21 for analysis. The closed-ended questions were analysed using descriptive statistics to highlights the key issues the participants had whilst interacting with the course content. The open-ended questions were coded and analysed by the thematic analysis method using Nvivo 10 software.

A summary of the analysis of the closed-ended questions is presented in Dzandu & Tang (2015) comes in the next section. This is followed by the results of the thematic analysis of the open-ended questions and the interviews with members of the eLearning content development team. The outcomes of all these led informed the development of the conceptual model and the subsequent design of the context-based interface framework as the first iteration of the main artefact for this study.

4.2.2 Results - Human Information Interaction experiences on an eLearning course

The data for the study revealed evidence of syntactic, pragmatic and semantics gaps such as inadequate representation of information, which affected the participants understanding and ability to effectively apply the content and new knowledge to future projects (Dzandu & Tang 2015). Thus, the content of the eLearning course was not pragmatic enough to guarantee an excellent fit be, perhaps because of some missing context information during the design and storage of the information in the LMS. This indicates that somehow, there were gaps either at the syntactic, semantic and pragmatic levels (Opoku-Anokye & Tang 2014) which had to do more with the information interface issues.

The 168 participants also responded to an open-ended question regarding anything they particularly liked or disliked about the course? The results from the thematic analysis of the open-ended questions using the semiotic elements revealed some challenges of the participants in their information interaction experiences on the eLearning course. It must be noted that only those issues that relate to the semiotic framework are reported. Therefore, the themes for the analysis were syntactic, semantic, pragmatic and social environment issues.

The results revealed some instances of information gaps on the eLearning course in Applied Statistics related to syntactic challenges. This include data validation problems because of inadequate information or instruction. These were expressed by some participants (e.g. #3, 14, 29, 82), and one of them had this to say;

> *"There were some difficulties on approximations of numerical answers"; "Decimal points did bring some confusion"; "I dislike it when the system does not accept the correct answer, say due to decimal conversion errors"* (Participant #3).

Another syntactic problem identified with representation had to do with the interface design. This view was shared by most of the participants (e.g. #14, 18, 20, 38, 59, etc.) although some indicated that they liked the current design of the interfaces. One of them stated;

> *"I like the design, but I would like the interface design for the course to be interactive"* (Participant #1).

Another syntactic problem with representation of the content was lack of sound, which is a context problem or an issue of format, and this affected participant understanding. Some participants (e.g. #12, 48, 60, 99, 124, 155) expressed these unequivocally, and one of them said;

> *"…there was lack of sound in most presentations. Please add this to facilitate better understanding"*(Participant #5).

The main issues had to do with semantic gaps or challenges, which affected participants understanding of the course. One such problem was system ambiguity, which some participants (#2, 14, 77, 40) claimed affected their understanding of the course. One of them put it this way;

> *"…am supposed to give an answer in two forms, to be specific-7% or----.the answer was .07 but it was not clear in which form the answer should have been, it could have also have been 4 out of 56"; "Most of instructions were not direct hence some of the question took too long to be understood"* (Participant #2).

Information dissymmetry was also evident in the challenges the participants faced. In the words of some of the participants (e.g. #7, 10, 47, 38, 53, 102), this was a source of confusion, as one did not know which one to trust. This situation made it difficult to understand the course. A participant stated;

> *"In many assignments, the flow of the contents in offline version was different from the online version (the way questions are asked)"* (Participant #7).

The problem of information dissymmetry is very common in data and information capture into IS/IT systems situations. When an event occurs in the environment and this needs to be captured into IS/IT systems, the modelling considers how to break the event down into manageable data units for the purpose of storage into IS/IT systems. The requirement analysis and the design of databases to support the data and information representation considers only the sign "what" aspects of the data. Subsequently, the design of the systems and interfaces come with limitations, inflexibility and data input constraints that do not allow for other context details about the sign of the event such as the "why", "how", and "situation" although in some instances the "who", "when" and "where" about the event can be implicitly captured by the system and database configurations.

The participants also highlighted the problems of inadequate information or content, which also affected their understanding of the course. Some of the participants (e.g. #14, 3, 19, 22, 62, 29, 57, 59, 74, 90, 120, etc.) shared in this opinion, and remarked as follows;

> *"There were some difficulties on approximations of numerical answers. More instructions especially about approximations is needed to make the course more enjoyable"* (Participant #14).
>
> *"May you in next time add more explanations especially on using the software and its functionality"; "There is need to give assignments on graph presentations"* (Participant #3).
>
> *"There is need for additional tasks on manipulation of data"; ".....but the problems were not there in the assignment and because we were not exposed to the notes, it needed more knowledge to find them"* (Participant #19).

The problem of non-exhaustive or incompleteness of some of the contents according to some respondents (e.g. #10, 16, 28, 46, 89, 133), affected their ability to acquire new knowledge on the course. A participant therefore suggested;

> *".....I advice that some of the topics to be expanded to get a wide range of knowledge"* (Participant #10).

The pragmatic issues bothered on usability challenges. There was evidence to suggest that some participants (e.g. #11, 34, 38, 55) had challenges in adapting the data to meet their intentions leading to some participants suggesting improvements in future design of the contents. For example;

> *"…….in future courses, ask participants to use their local climatic data in the course where available, and then let them submit both the data and results of their calculations online for marking"* (Participant #11).

At the social environment level, there were indications of lack of social contextualisation of the course content. Some of the participant (e.g. #1, 7, 22, 37, 63, 78, 98, 115) found some information and content irrelevant to which one participant suggested that in future run of the course;

> *"………ask participants to use their local climatic data"; "We should be taught how to format our local data for use after the course"; "The course is biased to agriculture."* (Participant #1).

The researcher also held interviews with the content expert (Interviewee #1), senior content developer (Interviewee #2), a tester (Interviewee #3) and facilitator (Interviewee #4), after reviewing the responses of the participants and critiquing the previous version of the eLearning course for the purpose of improving the content. From the interviews with the content development team, the interviewees confirmed the information gaps identified by the participants.

In response to the question on leaners complaints about inadequate context in some of content of the eLearning course, the content developer opined:

> *"..yes, there are challenges in capturing as much context in the contents provided by the content experts, however it is practically impossible to do so. I do aim not to have too much content on each scene in order not to bore the leaners, mindful of the fact that these are workers who do not have much time for lengthy content. The plan is to keep the contents brief but to supplement it with animations, sound, pictures, and possibly some narrations to engage the leaners"* (Interviewee #2).

The facilitator affirmed the concerns of the participants and remarked:

> *"….to compensate for lack of content I provide both live support through discussion platforms provided by the LMS; and offline support via emails by answering leaners questions and clarifying the contents which leaners had challenges with the content.*
>
> *However, I must say that some of the challenges had to do with technical issues about ambiguity in the instructions for installation of software, downloading of some datasets for practice, lack of understanding of the practice questions and in some cases usability of the system.*
>
> *I must say that in some cases, the practice questions and the dataset do not reflect that of the participants' local weather conditions and they find it difficult to contextualize and understand the practice task"* (Interviewee #4).

The tester also acknowledged the problems of missing or inadequate content in some of the course units. He had this to say;

> *"……yes, sometimes I am able to identify instances of inadequate information about some data or content which would make it difficult for the learner to understand. I do communicate these to the content developer.*
>
> *And in some cases when we (with content developer) hold discussions on my observations after the testing together with the content expert, it becomes clear that the intentions of the content expert are sometimes different from what the content developer*

captured; and what the content developer intended is different from how I also understood it. Our meetings after the testing are always helpful in improving the content of the course.

My role as a tester is to among other things, check for usability, understandability, logical flow, functionality of the features, and potential impact of the content on new knowledge acquisition by the learners. But for me the most important thing is to ensure that the content has enough contexts to help the learners to understand and form new knowledge." (Interviewee #3).

The content expert also affirmed the challenges in developing detailed contents for online learners who do not have the benefit of face-to-face interaction during the learning experience. He responded to the question by saying;

"*Yes, the issue of inadequate context in the course content is real and a very big challenge. As a content expert or writer, one of the biggest challenges you have to grapple with is how much content is enough for the learner to understand and form new knowledge. Even more so is the challenge for the content developer who must create compelling online content for the course."*

"We can only do as much when writing the content, because unlike in the face-to-face teaching model, where you have the chance to explain the course contents to the learners and clarify their doubts and confusions through questions and answer this cannot be said of eLearning. We have no option than to summaries the content as much as possible, albeit without losing the key issues." (Interviewee #1).

In response to how they handle the context and content challenges in the when developing contents for the eLearning course, the content expert, said;

"The development of the eLearning content is as much an iterative process between the content developer and I; and between the testers and the developer. We have a team of testers who are equally experts in the subject matter; and they help ensure that the key content and context are well represented by the content developer; whilst the other testers focus on the usability and functionality of the eLearning course".

"To compensate for inadequate context in the course content, we rely on the facilitators to help participants to understand the content and also contextualize the data, information and the knowledge acquired, where necessary within their local settings. We also try to provide opportunities for the participant to understand the content by our "options by context" approach. This feature allows the participants who are usually from several countries, to apply the data models to their country or local level weather conditions" (Interviewee #1).

The responses of the open-ended questions by the participants and from the interviewees (human actors), points to the issue of missing context or inadequate information being stored with the eLearning course content. This situation invariably affected the actors, especially the e-learners understanding of the course content. The sources of the missing information content and context, which occurs across the four layers of the semiotic framework, are shown in Fig. 4.1.

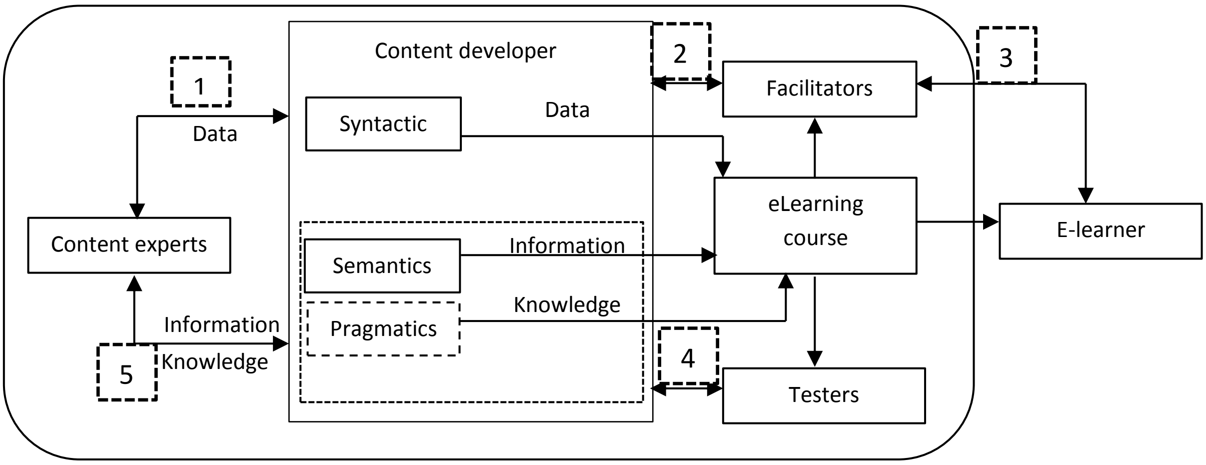


Figure 4.1: Sources of context gaps (1-5) among actors on an eLearning platform

This model (Fig. 4.2) illustrates opportunities for more context can be incorporated into the human information interface design for information systems to help improve the outputs from information systems by making the information more context specific for better understanding (semantic) and usability (pragmatic) (Dzandu & Tang 2015).

Although, not explicitly stated, the implicit indications are that context in the form of more “why”, “how”, “location” and “situation” about the data (i.e. content, datasets, instructions, etc) provided in the course content would in no doubt bridge the context deficiency gaps and improve understanding of the participants and all those other actors involved in the interaction process. In the light of the current challenges of missing context of information when data is stored in an information system, in this case the eLearning course, the researcher proposes a conceptual model of human information interaction (Fig. 4.2).

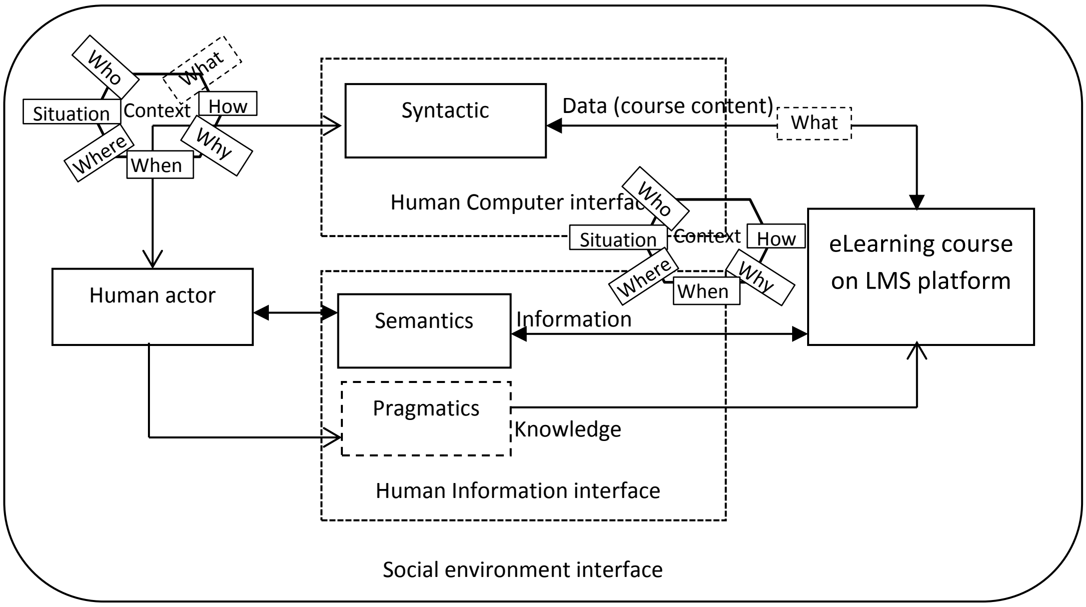


Figure 4.2: Human information interactions on an eLearning course
(adapted from Dzandu & Tang 2015)

The proposed human information interaction model is premised on the assumption that at the syntactic level, data from the content development of the eLearning course largely, is somewhat captured by the human computer interface (HCI) factors built into the eLearning course using both the LMS (Moodle) and Articulate Storyline (Articulate Global 2014). However, there are semantic and pragmatic gaps at the human information interface level where meaning of the course content is to be assimilated by the participants in order to construct the knowledge they are expected to gain on the course. Even more challenging is the issue of adaptability and application of the knowledge acquired on the course in the specific social environments of the participants, which is dependent on culture and many other factors within the participant's social environment.

4.2.3 Conclusion of the Preliminary Study

This exploratory study identified factors affecting participant's interaction with an information system (an eLearning course). The context gaps or problems identified occurred at the syntactic, semantic, pragmatic and social levels as per the semiotic framework (Stamper 1973; Liu 2000). The information interactions problems including ambiguous instructions, inadequate information, lack of sound, interface design problems were identified from the survey of past participants on the e-learning course (Dzandu & Tang 2015). The challenges of missing information context when data is stored in an information system were therefore highlighted and a human information interaction model is proposed. Future research could explore and test the proposed human information interaction model in business settings or with business information systems. The next section summaries what constitute the interface factors in order to model and validates how the interface factors impact on information and knowledge activities.

4.3 What lies at the interface between human actor and information object?

Human users have inert and social characteristics, which affect how they interact with information. For example, individual characteristics and culture; and factors within the environment have significant influence on how a person perceives, interprets, understands and use information. On the other end of the spectrum is the characteristic of the information object, which also influences how people interact with information. Given that humans interact with information through and interface, the question is what lies at the interface between the human actor and the information object?

In Chapter 2 (section), the review of literature (e.g. Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006; etc) helped to identify those factors that lie at the interface between the human user and the information object during human-information interaction. Using the semiotic framework as the analytical framework, a total of 10 factors, namely context, impacts, intention, acquisition, usability, quality of mapping, level of interpretation, information object characteristics, human behaviours, interaction characteristics were deciphered (Fig. 4.3).

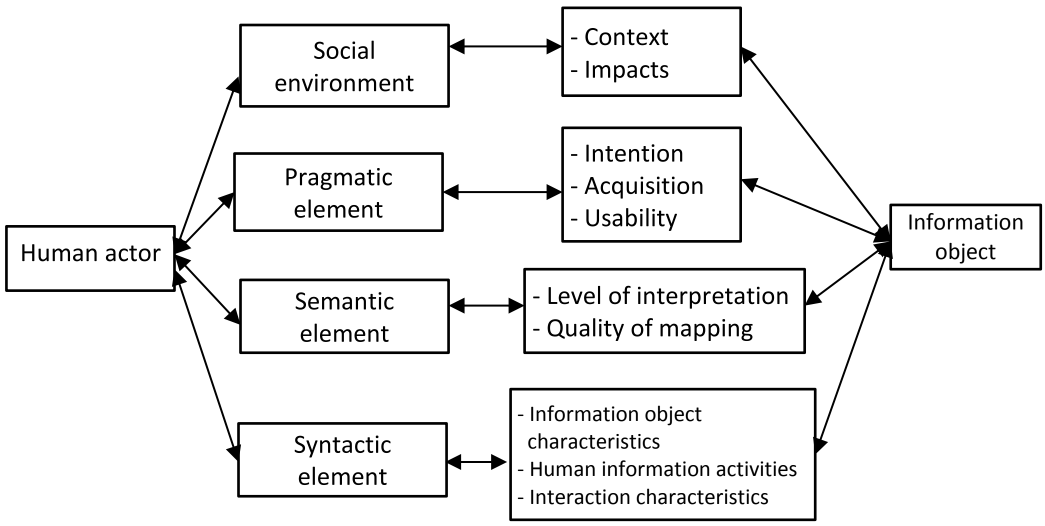


Figure 4.3: Semiotic Inspired Human Information Interface (HII) Model

The human actor has semiotic capabilities and uses these when interacting with information to make meaning, achieve understanding and optimise the use of information. The HII model (Fig. 4.3) therefore shows the identified semiotic components and constructs which are considered capable of having mediating effect on the interaction between human actor and information object. This model can have implications for assessing the quality of data, information and knowledge, especially those stored in IS/IT systems.

In order to develop and validate the conceptual models and the final HII framework, the human actor, interface factors and information object issues are assessed using structural equation modelling (SEM) and interviews. These were done at the data (syntactic), information (semantic) and pragmatic levels (knowledge) leading to mini frameworks for building context into the data, information and knowledge interfaces culminating in an integrated HII framework as the main artefact for this study. The next section describes the processes leading to the development of the context-based data interface framework representing the first iteration of the human information interface framework.

4.4 "Data in Context or Data of Context" – towards the design of context-based interfaces for IS/IT systems

The attempt to develop the HII framework requires a systematic approach through iterative processes to refine the conceptual model first into a context-based data interface, followed by information and knowledge interfaces for IS/IT systems. The literature review and the conceptual model inform the design of the framework by highlighting the specific issues to focus on in order to achieve the aim of developing the HII framework. The qualitative-quantitative approach was used to collect and analysed data.

4.4.1 Research Methods and Procedure

In this section, in-depth qualitative interviews were conducted with 18 respondents (see interview protocol in Appendix 5). The interviewees were made up of experts from UK; Ghana, UAE, Iran, and Chile but most of them currently in UK. The interviewees work in various industries including consulting, data solutions, banking, finance and financial market, security sector, software engineering, telecommunications and NHS. The interviewees had a between 4-30 years working experience. The interviewees were either working full or currently pursuing further research degrees in Universities in the UK.

The interviewees were purposively selected for the study because of their extensive professional and academic background and experience in data and information analytics, systems development, research, and software development roles. The ethnic diversity of the expert reviewers brings some cultural richness to the data. The mode of data collection was face-to-face with all the interviewees since they were all available and accessible in the UK except those who were in Ghana where skype was used. In all cases, the consent of the interviewees was first sought after which a copy of the semi-structured questions was sent to them ahead of the interview (Appendix 5). Dates and time were agreed and fixed for the interviews. The questions covered on the nature and capture, retrieval and use of context details for data, information and knowledge activities, prospects and challenges of developing context-based or intelligent interfaces for IS/IT systems.

The interviews were held in various locations depending on the interviewees' convenience but mostly in the Informatics Research Centre seminar room at the University of Reading, UK. Most parts of the interview questions had been typed written or answered on the template by the interviewees but were re-echoed at the interview sessions. Although, it was meant to be a structured interview, where necessary additional questions were asked during the face-to-face interview sessions to clarify any ambiguities. The interviews were recorded and transcribed for the purpose of cross checking the responses with the type written answers and to update the initial typewritten answers by some of the interviewees.

The data analysis procedure for the qualitative data follows the six phase thematic analysis process (Braun & Clarke 2006). This includes familiarisation with the data during transcription where the recorded responses were replayed several times and initial ideas were noted leading to the second phase of generating initial codes. The codes were collated into themes (i.e. validity, applicability and utility). The fourth and fifth phases involved the reviewing of the themes and refining of the themes to tell the overall story. All these were accomplished using NVivo 10. The last phase of the process was the presentation of the results as shown below. The thematic analysis made it easier control the scope of the interview, the responses whilst providing evidence of the expert interviewee's response to the particular issue.

4.4.2 Responses from the interviews

Are current interfaces of IS/IT systems intelligent? If not, why and how does this affect the quality of data and information we capture and store in IS/IT systems.

> *"No, I don't think current interfaces are intelligent enough, intelligent do not allow us to enter as much details about data, information or events"* (Change Management and Data Protection Officer, Shipping Company, UK).
>
> *" ….the interfaces can be designed to be intelligent based on what you want to do and the system specification. For example, as part of a team we develop a software for a bank, by building a store of state machine based on business rules, regulations and policies, and depending on the client profile details, the state machine can trigger an action for the bank staff and for the superior to approve a service or product for a client", so yes intelligence can be built into the*

interfaces, but I don't think current interfaces have the kind of intelligence that you are talking about-context" (Software Engineer, Consulting Firm, Chile).

> *"No, current interfaces of IS/IT systems are not and cannot be said to be intelligent. Perhaps we should talk about it in terms of computer-based information systems (CBIS)…….they currently keep and will ever keep data or information but cannot be intelligent. CBIS can only be intelligent if business rules are stored with the data or information to help the system to derive sense. CBIS only store a bunch of data and information, which serves as the ingredients for sense making…..making new sense requires an intelligent agent, which can be human or artificial intelligent which are built to replicate human intelligence. Current interfaces are designed based on the 'mental restrictions' of designers to allow for only a fraction of the context of an event, in this case the "what" to be communicated".* (BI Analyst and Solutions Architect, Consulting, UK).

> *"Not actually….not designed in terms of context but based on frequency and statistical properties which helps to visualise, create relationships and bring some basic intelligence to bear. However, recent decade interfaces are intelligent using AI, web of knowledge and semantic models."* (Research Scientist, NHS, UK).

The interviews also expressed their opinion on the effect of lack of context on the quality of data and information stored in IS/IT systems.

> *"As to whether this affects the quality of data and information, I will say the quality of data is never affected, it is the quality of information that is affected since that depends very much on context and human understanding and interpretation."* (BI Analyst and Solutions Architect, Consulting, UK).

> *"Yes, of course, the quality of data and information currently stored in IS/IT systems suffer from lack of or inadequate context. However, recent AI interfaces are designed with the know how to store and retrieve focused data/information or key variables for specific purpose."* (Research Scientist, NHS, UK).

From the responses, it was clear that current interfaces are not necessarily intelligent to be able to provoke users to provide those details that will make IS/IT systems more intelligent. Current interfaces of IS/IT systems are not designed to be able to garner all those context details about data defined in this study. Current, interfaces follow a "reductionist" principle (Gibson 1979), where events are reduced into limited data details and stored in in IS/IT systems based on the systems constraints (Norman et al. 2003) especially in the design of the databases. IS/IT systems are basically a storehouse of the "sign" (Stamper 1973; Liu 2000) about the data but not the reasons (why) or the processes leading to the occurrence of the events (how) within the environment. The lack of intelligence of the IS/IT interfaces were perceived as capable of affecting the quality of data or information stored in IS/IT systems.

In your view, do you think meta-data associated with current design of database tables serves the purpose of context information about the data stored in databases? Can meta-data provide you with all the context details about a particular data in terms of the "why" and "how" about the data.

> *"No, I think meta-data is just data about data, and if the context details are to be stored with the data it will only create an endless list of data about the data, as each meta-data will still be talking about the "what" of the data in terms of format, structure, data type, etc. So meta-data does not provide context but descriptions and properties about the data. If we have to store the other context details about data such as the "why" and the "how", then that has to be done at a completely different level. Therefore, although current meta-data perhaps call it "meta-what" captures details about an event, it only provides minimal context and for that matter very little semantic or meaning about the data. Meta-data provides some but not all context about an event and the degree of the context details depends on the designer of the system and the boundaries of the event (which defines the context). For example, when I design E-R relationship models for clients, I do add a mapping documents which is a meta-data and with respect to context, I do specify and define the "who", can do "what" with the entity "when" certain conditions are met, and also include conditions under which those entities can be applied when designing the final system. So, I would say I do add some element of "how" which I see as characteristics of the "what". But, generally, I will say current meta-data are inadequate to provide all the context details about data"* (BI Analyst and Solutions Architect, Consulting, UK).

> *"....meta-data is about characteristics of the data, but not about the "why" and the "who"………..you know how databases work, tables, primary keys and foreign keys linked together. Meta-data.....hmmmmm; if more context is to include the "why" and "how" then for instance now we should be talking about "meta-why" which can be linked to the meta-data"* (Software Engineer, Consulting Firm, Chile).

> *"……. in my workplace, we collect a lot of details about a device about 140 fields for each device, but yes, I agree this is all about the characteristics and properties of the device ("what" the device is in terms of the type, camera, size, etc.)……we do not include the "why" or the value of each data fields. But as data solutions providers, we know the value or motivation for what we do with our datasets and this is captured in our vision, mission statements and business strategy"* (Research Analyst, Consulting Firm, Reading, UK).

"No, I don't believe it; meta-data doesn't reflect all of the context details we expect of such systems. It doesn't determine the context, and semantics depends on how the system is being used. Meta-data is usually what we see when we go over the data, but it is not enough, although in some cases it could be enough. For example, if we take the meta-data for a news item, we could have some context, but we can't understand the whole story just category, hierarchy. But more meta-data, more meaning and better understanding. Data is abstract level of the structure, with underlying issues related to context. Thus, context is related to structure which reflect some key variables". (Research Scientist, NHS, UK).

The findings that emerged from the interviewees was that meta-data is insufficient as a source of context information as defined in the study. The need to capture the "why" and "how" of the data resonated through the responses from all the interviewees and the concept of "Meta-why" offers a very interesting approach worth pursuing to design context-based data and information interface for IS/IT systems.

In order to garner evidence about the need, and possibility of designing context-based data and context-based information interfaces, interviewees were asked whether it is possible to capture more context details such as "why" and "how" about data or information when it is being stored in IS/IT systems? The responses revealed that most of the interviewees were receptive to the idea but were unsure how it can be done. The general opinions expressed by the interviewees include:

"*It is difficult but not impossible. In the larger society, rarely will people want to go the extra mile to capture all those details about data or information when they use a system. For example, if someone goes online and wants to access a service, it will be too much to ask of him or her to indicate why he/she wants to access that service. When this happens, people will stop using the systems and forgo the service. However, in an organisation, it is possible as employees will be compelled by the policy of the organisation to comply and do this, and they would have no choice*" (Software Engineer, Consulting Firm, Chile/UK).

"That will be too much to ask, I can probably do with a few details like who, what and where about a person or an event .....but not more. I'll rather not use such systems" (Change Management and Data Protection Officer, Shipping Company, UK).

"Context is subjective and extremely difficult to communicate and capture. On the other hand, fact is objective and current design of databases and IS/IT systems allow facts to be captured. Also, techniques from programming, systems design; AI (artificial intelligence) etc. has been widely used to capture to capture some amount of context, albeit very minimal. All these issues boil down to communication and semantics. In a machine-information communication, information is communicated in the form of binary digits, because that's the language of the

machine (binary digits). But in a human-information communication, achieving understanding and for that matter semantics is complex. Until such a time that machines and humans can achieve a common semantic understanding and make the same sense of an event, semantics will always be a function of the human mind." (BI Analytics Consultant, Consulting, UK).

"*Certainly, this requires a different storage level. Could be reasons, consequences, past experience, it is possible to store this but if it has to be done, it must be structured text/unstructured rather than as binary or categorical variable. It must be noted that for business for example the "why" depends on business requirement, objectives, and competitors among others. From my experience working as a software engineer and IA system developer in businesses, for most part they don't usually store the "why" details during data capture (I will say 7/10 they don't), but for me 3/5 of the times I do store such details probably because I develop AI systems".* (Research Scientist, NHS, UK).

On the issue of context of data or information with respect to the "who" details, the interviewees were unanimous in their responses;

"Some of the context issues such as the "who" has been somewhat dealt with because current IS/IT systems have provision for the creator of the data or the person who captured the data and the users (modifiers) of the data. However, these details are inadequate if we talk about real who of the meant for audit trails or IS/IT system audits but not as a source of context (though partially) but in a typical workflow in an organisation….as I said before there are more "who's" involved in a chain of activities leading to an event/data". It is also worth noting that the current "who" about the data in terms of creator and user of the data in a system, are insufficient and cannot provide real insights for detailed intelligence" (BI Analytics Consultant, Consulting Firm, UK).

"For the issue about "who" of data or information in an IS/IT system, I will say it depends. Once again, let me once the example of the banking software my team developed. Stored data in the system can be linked to the creator of the data (bank staff) as well as all the subsequent users of that data or information. This can be checked from the log files, etc. However, these are only for system audit purposes and provide only a fraction of the context information on "who" about the data" (Software Engineer, Consulting Firm, Chile).

The illustrations of the "who" of data from the banking scenario is shown in Fig. 4.4.

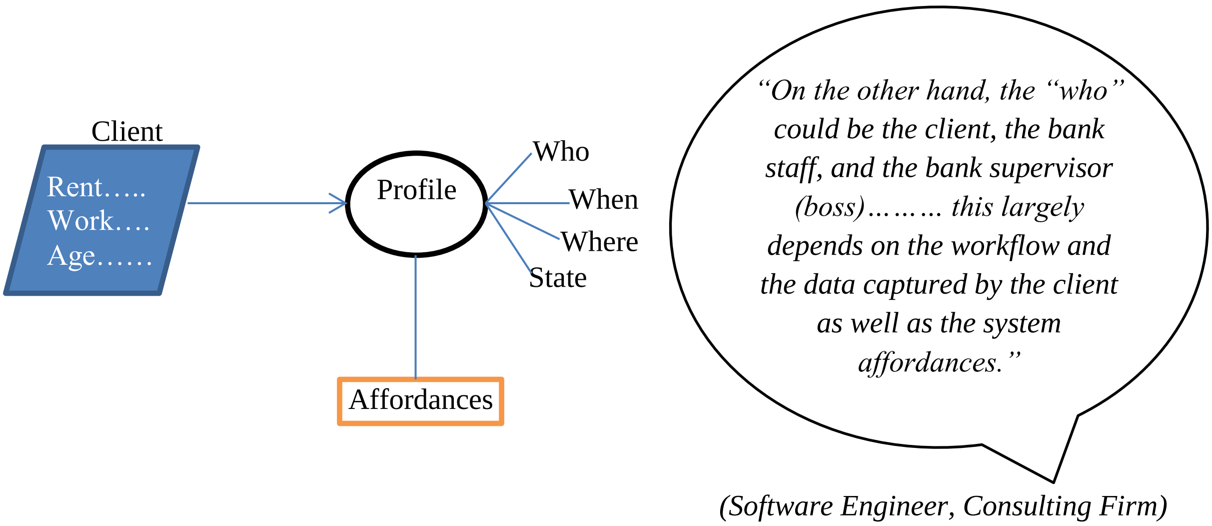


Figure 4.4: "Who" as an External Client

Context of data relates to information about an event within the environment. Using the "why" and "how" about a situation, one of the interviewees demonstrated the link between the environment (culture), data and context (Gibson 1978; Gibson 1979) as shown in Fig. 4.5. He uses the illustration in a rhetorical question saying, "for example, why I am here at this desk in IRC- to study for my PhD"

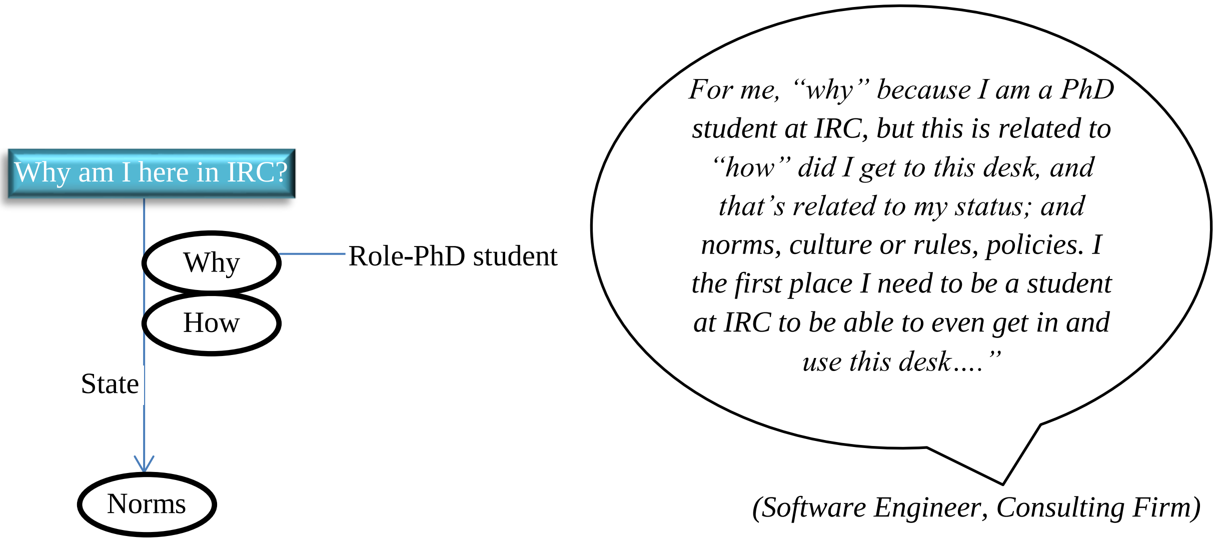


Figure 4.5: The "Why" and "How" as a function of Norms

> *"Also, with the system settings of computers and IT gadgets, it is easy to obtain data about the time ("when") and location of the data source and with IoT and sensors, it is even more easy to obtain the "where" or the location of the data source. However, as to whether these are stored with data/information purposely because of context depends on the owner of the IS"* (BI Analytics Consultant, Consulting, UK).

Whilst acknowledging the significance of capturing the "who" and "why" details of an event (Fig. 4.6), one interviewee remarked as follows;

> *"In my opinion the need to build the "why" aspect of context of data or information into systems interfaces is the most important. But for now, it is a function of the IS/IT system (state machine or reference engine). This can also be illustrated with the same banking project as follows":* (Fig. 4.6)

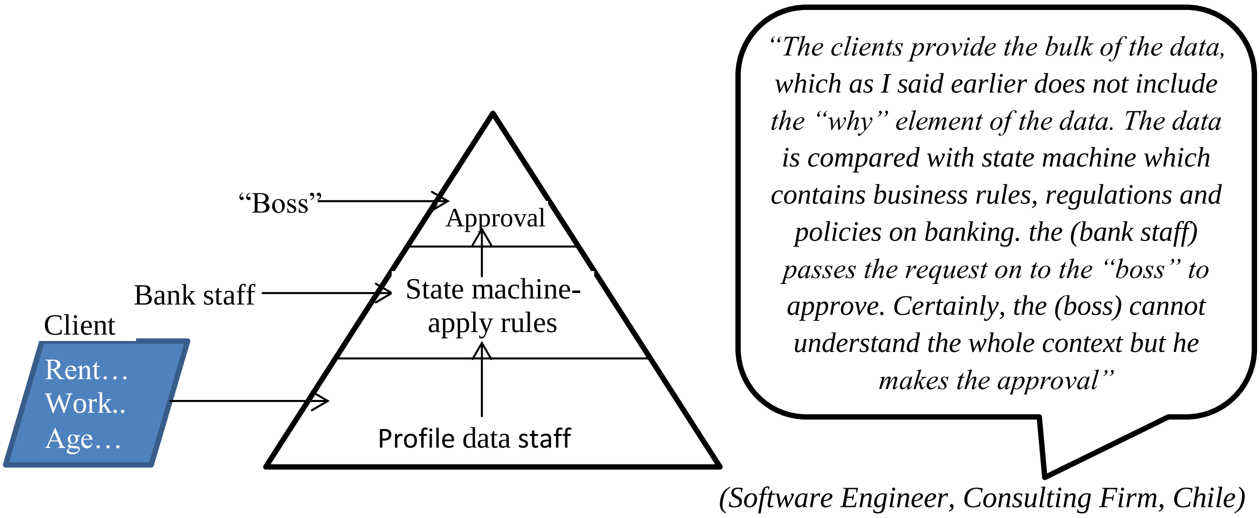


Figure 4.6: "Who" as an External Client in Bank

Another illustration of the complexity of capturing the "who" about data was demonstrated by the information security analyst as shown in Fig. 4.7;

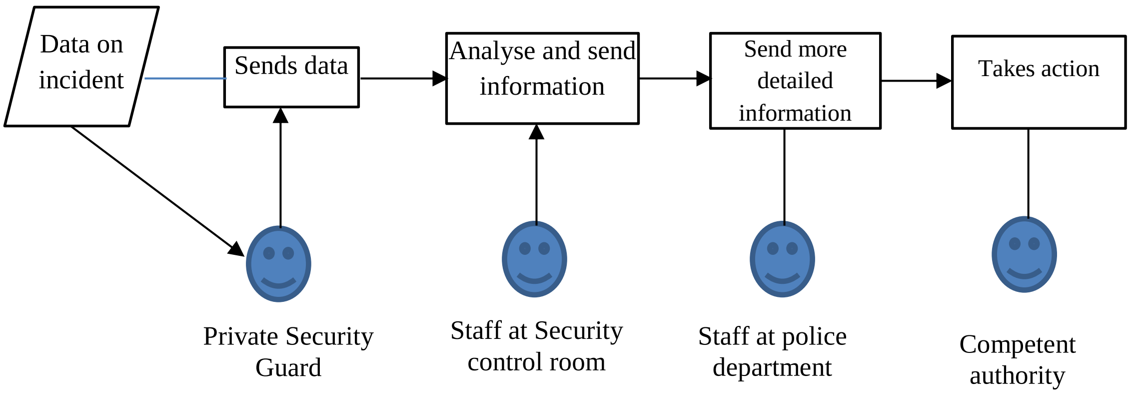


Figure 4.7: "Who" as actors involved in sharing security information about an incident

> *"As you can see, there are four actors involved in sharing information about an event at a site. First is the private security guard (Actor 1) who observes the incident, then sends data on the incident to a staff at the security control room (Actor 2). The staff in the control room analysis the data to produce information and then relays the information to a staff at the police department control room (called it Actor 3) who also interprets the information to the competent*

authority (Actor 4) who takes action by commanding the appropriate unit (fire, ambulance, specialist personnel) to respond the incident." (Security Information Analyst, Security Sector, UAE).

It can be deduced from the scenario in Fig. 4.7 indeed the there are multiple "who" involved in sharing of information about an incident, however, one interesting thing that emerged was that without adequate context on the data about the incident passed on from the private security guard, Actors 2, 3 and 4 seem to rely on some assumption to create and relay information among themselves. Thus, similar, to the situation in Fig. 4.6; the if Actor 1 does not capture all the context details, Actors 2, 3 and worst of all Actor 4 cannot understand the clear picture of the incident. So yes, many actors ("who") and potentially lack of context (if not stored by Actor 1) as data or information is shared among the multiple actors. The Security Information Analyst affirmed this situation. Generally, although the interviewees were positive about the possibility of capturing context details such as the "who", "why" and "how" about an event, they had some reservations for now.

On situation (Sowa 2003) as context of data, some interviewees felt that it is an encapsulation of the other context variables defined in the study. These opinions though were expressed by a few of the interviewees are worthy of reference. They remarked;

"In addition, "situation", to me, is a function of the "what", "when", "where" and "who" and these have somewhat been addressed, so the key issues when you are talking about context should be about the "how" and "why" of the data. "How" the data came to being terms of the events, circumstances or happenings leading to the data and the "why" or the reasons why the event occurred are the key context needed for insights, intelligence and knowledge. These two issues are more about the human being rather than the IT systems, not until you find out from the "persons" involved and they tell you the reason, which can then be stored at a different level and linked to the data (what), then decisions, actions and knowledge learning including machine learning can only be based on the users (human and IT system) assumptions" (BI Analytics Consultant, Consulting, UK).

"To me the context variables, of what, how, when, where, situation can be summarily described as "state" of the data. And the state of an object may change with time, for example, if you collect data on the phone number of someone today for communication purpose ("why"); in future, with advances in technology the purpose might change might change from just calling to adverts via messaging……(this means the why has change) and the state of the data has therefore change. So, context might be likened to the "state of data" at a moment in time" (Software Engineer, Consulting Firm).

The technical challenges of designing context-based data and information interfaces were acknowledged by the interviewees. Some of the views expressed were;

> *"This is certainly a challenging task…but it is possible. Even the capture the "who" of the data is a challenge. For example, in a workflow or organisational processes involving data about a contract signed by a company, the "who" about the data will not be only the person who captured the data about the contract into the database of the organisation…..but it may have to include all staff who were involved in the processes leading to the preparation of the contract and the signing of the contract. Even the details about those who signed the contract and witnesses if any could be part of the "who" about data on a contract. So yes, it is possible but that will mean more work for staff. However, in organisations, employees will have no reason not to capture all these details if the work roles/responsibilities and the policies of the organisation requires them to do so. The lack of context information about data is a huge issue out there in industry"* (BI Analyst and Solutions Architect, Consulting, UK).

> *"It raises the question of usability; the interface would not be said to be usable. Interfaces and systems should be easy to use, brief but informative". And in the banking case study I have used in this interview, there is even system security implications or challenge"* (Software Engineer, Consulting Firm, Chile).

Some of the interviewee viewed the challenges of building context interfaces through a socio-technical lens and summed it all up as follow;

> *"The major challenge involves providing the necessary hardware infrastructure that is capable of assisting the provision of context-based data and context-based information interfaces for IS/IT systems. Context-based IS/IT system require the use of sensor and controller devices that can be programmed and modelled to behaviour differently based on the situations or context on data or information. More specifically on robotics and AI/BIA systems, these will be necessary. However, programming sensors and thinking of all possible situations to be programmed is a challenge. Another challenge is translation of all the various user preferences into contextual issues to be programmed is another challenge. Basically, data abstraction issues will be a great challenge"* (IT Manager, Stock Market, Ghana).

> *"It can be designed but it may not be applicable to all situations. Also, the design would need to consider user behaviour as well and this can be challenging but might not be always applicable and useful. For business entities, there is the need to have clear objectives, clear purpose and aim for designing context-based systems.*

Another challenge would be the need for critical requirement analysis on how to obtain such context information and to design the system without compromising on the interactivity. Users want their interactions with systems to be short and comfortable. There might my ethical issues as well as users would not want to be identified but to enhance usability of context-based systems, for businesses, they can offer reward or incentives to encourage them to provide that context information which can then be used to delivered improved products and services to them". (Research Scientist, NHS, UK).

The indications from these responses are that a range of technical challenges must be overcome if the design of context-based data and information interfaces for IS/IT systems are to be successful. This include cultural issues (organisational culture), user challenges, availability of the necessary hardware, behaviour modelling, discerning context situations and data abstraction. However, despite all these challenges, the interviewees were very positive when asked about the prospects of context-based interface.

The prospects of building more context into the data and information interface of IS/IT systems, were explored. All the interviewees were hopeful about the potential of building more context in data and information in IS/IT systems. Their responses suggest that this will not only enhance the quality of information and knowledge derived from stored data/information in IT systems, but it will also make computers more intelligent.

"The potential of these efforts (providing more context for data and information) is huge for industry…..certainly it will help improve decision making, business intelligence and business activities. …...machine learning and deep learning, machine learning is more geared towards generalisation whilst deep learning is for specificity. Obviously for deep learning, more contexts would make a huge difference. But natural language processing seems to offer benefits of cutting down the cost of training data or machine learning. However, until NLP also factors in more contexts, especially about the "why" of the data, AI and computer intelligence can only be approximation of the real truth". (BI Analytics Consultant, Consulting Firm, UK).

"…….surely more contexts will make systems more intelligent. But to me, being able to store the initial "why" is the most important as machine can then be trained to learn from this. My concern however, is, what happens when the "why" changes…..may be have a store of "meta-why's" which can be linked to the data with the meta-data. But certainly, more contexts is important to make data sensible". (Software Engineer, Consulting Firm, Chile).

"…this is certainly an interesting project and would make a huge impact in industry. As data scientist and in my role, as Head of Data Science, my team iteratively have to engage with client

(both staff and customers) at each point along a process flow or service encounter to be able to gather the needed insight and intelligence and develop appropriate data solutions and services for our market". (Data Scientist, International Company, UK).

It can be gleaned from the responses that the interviewees had positive outlook about the prospects of building more context into the data and information interface of IS/IT systems. However, the popular opinion of the interviewees was that it is a challenging task but not impossible.

4.4.3 Summary of the Results

The following are the main findings of the study:

1. Current interfaces of IS/IT systems are not intelligence to induce the capture of context-based details from users
2. Human actor and IS (interface) factors affect data storage and information retrieval from IS/IT systems
3. Objects/events occurs in the environment with it associated context details including "what", "who", "when", "where", "how", "why" and "situation"
4. "how" and "why" context-details were considered the most significant for understanding, interpreting and use of data.
5. The concept of "meta-what", "meta-how" and "meta-why" emerged as an approach for the design of multi-dimensional databases to support context-based interfaces
6. challenges identified in include difficulty in data abstraction for context, multiple instances of context details, and dealing with changes in the state of the context variables
7. There are huge prospect for the design of context-based interfaces to support data capture, information and knowledge activities.

4.5 Building Context into Data Interface

The literature review, and the preliminary study identified the sources of the problem of missing context in stored data to the **user** (interpretant) and the **interface** of the IS through which the data is captured. The human actor (user) who perceives and captures the data into the IS/IT system using a reductionist principle (Gibson 1978) is thus a significant source of the problem just as the constraints imposed on the nature of current IS/IT system interfaces. The response from the interviews have also confirmed the nature of the missing context details in stored data, its relationship with human factor and the interface factors as well as the implication for the quality of data, information and knowledge derived from IS/IT systems.

The source of the phenomenon, event or object to be perceived is the environment (Wang et al. 2018). Therefore Gibson (1978) and Wang et al. (2018) avers that information about an event, object or phenomenon exist in the environment and can be perceived by humans. When an event, object or phenomenon exist in its entirety in the environment with considerable context details such as “what” it is about (identity), location or “where” it exist, time or “when” it happened, actual intention or “why” it happened; “how” it happened (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007); and the situation (Sowa 2003) under which it happened. It is therefore argued that these context variables should be modelled the same way in IS/IT systems when it is being perceived and captured by the human actor (interpretant) as data (sign) for storage in IS.

The failure of the human actor to capture context details leads to the loss of vital attributes of the object, which would enhance users understanding of data when it is subsequently retrieved for information and knowledge activities. Therefore the role of human actor or the person (Brazier et al. 2000; Hofstede et al. 2010; Yoo et al. 2011) as a source of missing context in data stored in IS/IT systems is confirmed. However, given the complexity of measuring the human factor (user) in this study, individual culture (Yoo et al. 2011) is used as a proxy for human factor (user) as since data, information and knowledge activities are usually carried out at the individual level. Individual culture therefore affects the storage of data and retrieval of information of information for knowledge activities.

Another source of the missing context in stored data in IS/IT systems was the limited nature of current IS/IT system interfaces. The inflexibility and limitations of IS/IT systems at the syntactic level is re-echoed by (Brazier et al. 2000) who opined that at the object-level interaction, there is usually a one-sided interaction where there is only exchange of factual information initiated by the system. In other words, users can only enter those context details (particularly the “what”) based on limited specification of strategic preferences set by the systems owners and system designers. The user is not given much opportunity to capture more context details or change the object-level information. It is therefore argued that interfaces of IS/IT systems should be design for flexibility to support the capture of the proposed context details by users, hence the proposed context-based data interface framework (Fig. 4.8).

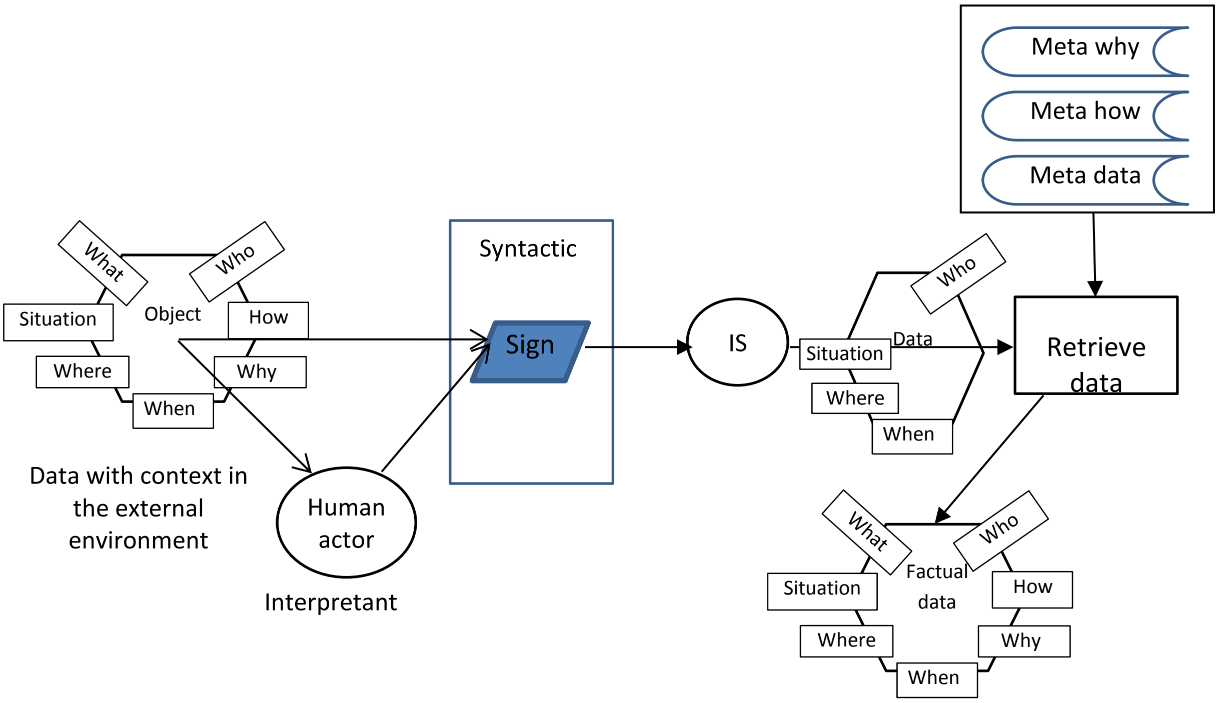


Figure 4.8: Mini artefact 1 - Context-based data interface framework

The responses from the interview also confirmed that the current nature of databases that serve as the backbone of IS/IT systems do not allow for data storage at multidimensional level. This has consequently resulted in interfaces that do not allow for the representation of other context information such as the "why', "how", "where", "when", "who" and "situation" in addition to the "what" at the syntactic level. From the interviews, the concept of "meta-what", "meta-how" and "meta-why" emerged as a multi-dimensional approach to the design of databases to support context-based interfaces.

An approach to developing a framework that incorporates user's pragmatic needs and social context into the data interface of computer-based information systems has been discussed. The responses from the interviews confirmed the problem of missing context in stored data leading to the proposed approach of designing multimodal interfaces as well as multidimensional databases capable of representing all the proposed context details of data/information. In the next section, data from survey would be used to validate the model and ascertain whether context-based object has any impact on the quality of data stored in IS/IT systems.

4.6 Validation of the Context-based Data Interface (CBDI)

Data represents events, objects, or phenomenon in the larger environment (social world), which denotes its context characteristics. The context characteristics may be "what" the event/object is, "when" and "where" the event happened; "who" was involved or perceived the event; "how" the event happened (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007), and the "situation" under which it happened (Sowa 2003). Clearly, data is inseparable from the social world or the environment and the human actors who perceive the event as "data". This means that the human actor is the main "agent" involved in the process of recognising an event as data through semiotics and other cognitive processes.

An event (data) has several contexts characterises; but during the process of capturing the data into IS/IT systems, not all the necessary context details are stored in the systems. This is due partly to the physical constraints of IS/IT systems and the human actor who applies some selective biases and through some reductionist approach captures only part of the event (data), and for systems, that is the "what" components. Consequently, stored data in IS/IT systems lack adequate context (Opoku-Anokye 2014; Dzandu & Tang 2015). The problem of missing context in stored data has implications for the quality of data. Therefore, the availability of context-details about an object would have a significant positive impact on the quality of data stored in IS/IT systems.

4.6.1 Method and Data Analysis Procedure

In this section, data from questionnaire survey is used to establish the relationship between an "object" (in the environment with context details of "what", "who", "when", "where", "how", "why" and "situation" (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007, Sowa 2003); the sign (referent) that represents the object in an IS/IT system; with human actor (interpretant) as the mediator of the process. The relationship between the data (object), sign (referent) and the human actor (interpretant) is based on Pierce's semiotics triangle of object, sign and interpretant. For the purpose of the structural modelling, context-based data is used as a proxy for object; data quality as the proxy for the sign stored in the IS/IT system; and human factors or individual culture is used as the proxy for interpretant or the human actor (Fig. 4.9).

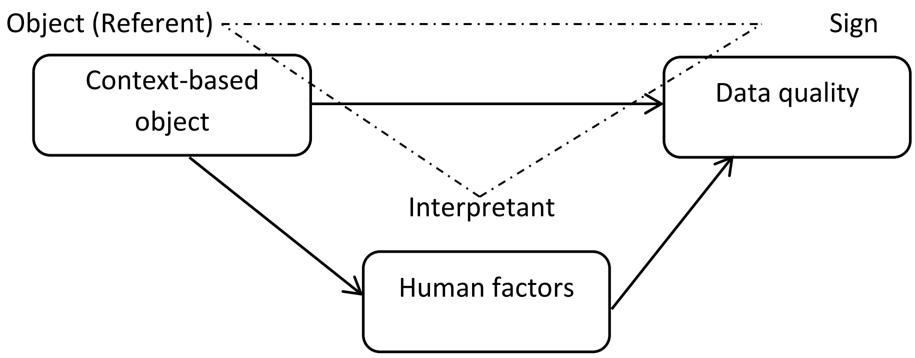


Figure 4.9: General Model of the Context-based data interface

4.6.2 Pilot Study: the impact of individual culture on human information interaction

The study setting was a higher institution of education, specifically the Henley Business School, University of Reading, UK. Students were asked to consider their interactions with any computer-based information systems they use in the University for academic activities. The examples of such IS included but not limited to subject specific databases, online catalogues, student's records management systems like RISISweb Portal, course information systems like Blackboard, etc.).

4.6.3 Method

This study explored the potential impact of culture specifically individual culture (denoted as human factors or HF) on selected information activities (IA) and mediated by human interface (IF) factors (Fig. 4.10). Based on evidence from literature, some pragmatic elements identified as factors of the human-information interface (IF); were used to developed items to represent the main constructs namely intentions (Hawizy et al. 2006; Blandford & Attfield 2010), usability (Abran et al. 2003; Scholtz 2006; Scholtz 2006; Ong & Lai 2007), and acquisition (Barron et al. 1999; Kraaijenbrink & Wijnhoven 2006).

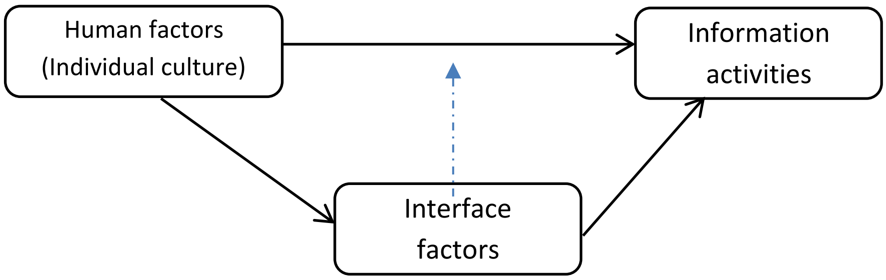


Figure 4.10: General Research Model

Section A of the questionnaire covered the context of the study with questions on information activities with computer-based information systems. Section B covered question on respondents' interactions with information in computer-based systems with a focus on the factors that lie within the human-information interface based on some elements of the semiotic framework (Stamper 1973; Liu 2000). The pragmatics elements were measured with 5-items each on intentions, acquisition and usability; 3-items were used for the semantic element; and 1-item was used as a proxy for the social environment element. The syntactic element was not considered because information, which was the focus object of interest, had already been represented in the computer-based systems scenarios used (databases, online catalogues, student's records management systems like RISISweb Portal, course information systems like Blackboard, etc.).

Section C of the questionnaire consisted of the 26-item Hofstede's CV scale (Yoo et al. 2011) for individual cultural (differences adopted and adapted for information activities). These included 5-items each on power distance (PD) and uncertainty avoidance (UA); 6-items on collectivism (CT) and long-term orientation (LO) and on 4-items on masculinity (MA). Section D of the questionnaire covered the demographic information of the respondents (see Appendix 4).

The human factors could impact on information activities, and on the interface factors. In addition, the interface factors in turn impact on information activities and in addition mediate or moderate the effect of the human factors on information activities (Fig. 4.11). Although, the demographic variables could potentially moderate the effect of the human factors on information activities, the analysis did not cover this.

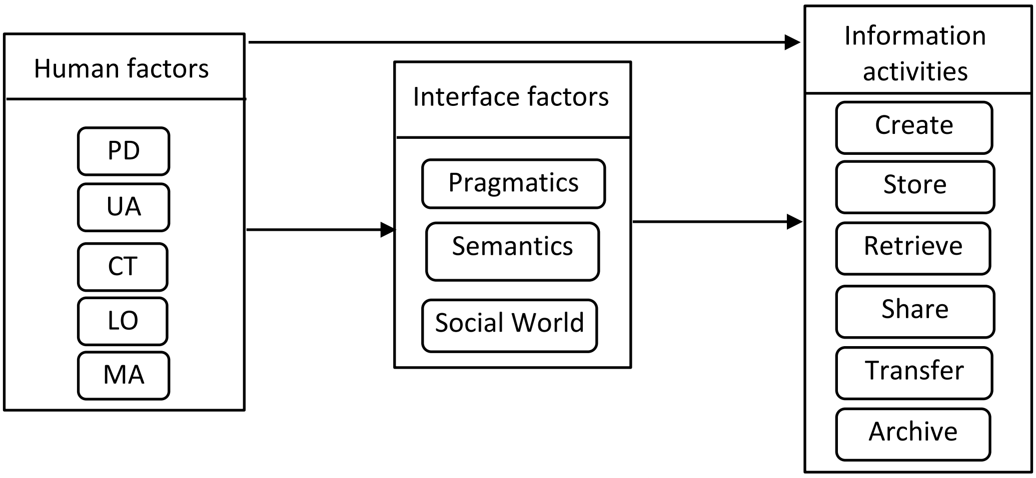


Figure 4.11: Research Model for the Pilot Study

The questionnaire was administered face-to-face to PhD students at the Henley Business School, University of Reading, UK. The responses were coded, captured and analysed using SPSS version 24. Given that this was the first attempt to adopt and adapt the CVS to information activities, all the 26-items together with the 18-items developed from literature were tested for reliability. The reliability test was pitched against the recommended Cronbach alpha of 0.70. In this study, the information activities were captured as binary variables (Yes or No) and for this reason logistic regression was used to establish and test the significance of the relationships at 95% confidence level. Linear regression was used to test the relationship between human factors and interface factors as these were transformed form Likert scale into average scores. However, the second order analysis was not robust due to the limitations of the measurement of the constructs, and the small size. The improved questionnaire and larger sample size to is used in the next phase to allow for a more robust second order and mediating or moderating effect analysis using SmartPLS.

4.6.4 Results of the Pilot Study and Improvement of Questionnaire

The reliability tests for all the 26-items on the CVS, the 18-items on IF and the 6-items on IA yielded very high Cronbach alpha of 0.847; 0.944; 0.814 respectively. These were all above the recommended threshold of 0.70; therefore, all the items used in the instrument were reliable, had high internal consistency and accurately measured what they were meant to measure. It is noted that the pilot study was a preliminary effort to partly highlight some aspects of the research problem and also adopt and adapt the CVS on individual culture to information activities context; which hitherto has not been done before as evidence of it could not be found in existing literature. This study was also meant to test the validity and reliability of the instrument in anticipation of using it to collect additional data to support the development, validation and evaluation of the HII framework. Furthermore, the results of the pilot helped to refine the research models for the quantitative analysis in terms of nature and direction of the relationship between the constructs by clearly identifying the mediators, the dependent and independent constructs.

4.6.5 Measurement development and data collection

Following the outcome of the pilot study, an improved questionnaire was design for to collect data for the main study. The questionnaire used for this part of the study had four sub-sections namely interface factors, individual cultural towards data storage and data quality, and a section on context-based data. The remaining sub-sections was on data quality. There was also a section on demographic characteristics of the respondents. The measurements for the items were carefully developed after critical review of literature and similar instruments by assigning numbers in a reliable and valid way to each of the items on a 7-point Likert-scale (Oates 2006; Olivier 2004; Zikmund et al. 2013). The key constructs, items and sources of the questions are shown in Table 4.1.

Table 4.1: Constructs used in the SEM questionnaire

Constructs	Items	Source
Data Quality	Completeness, Unambiguous	Wang & Strong (1996)
	Correctness	Karimi et al., (2004); Wang & Strong (1996)
	Meaningful	Ravichandran & Rai (1999)
Context-based data (CBO)	Who, why, where, when, how and what	Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007)
	Situation	Sowa (2004)
Interface factors	Context, impacts, information object characteristics, human behaviours, interaction characteristics	Marchionini (2008); Barron et al. (1999); Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Individual culture	Power distance, collectivism, uncertainty avoidance, long-term orientation, masculinity	(Yoo et al. 2011)

The questions in all the questionnaires used were very brief, unambiguous and easy to answer (Rogers et al. 2011; Myers 2009) in order to achieve high response rates. The items in the questionnaires were tested for reliability and validity. According to Straub et al. (2004) and

Venkatesh & Brown (2013) the quality of measurement of constructs depends on reliability; which is a prerequisite for validity (Venkatesh & Brown 2013) especially in quantitative research.

The questionnaire (Appendix 4) which had a total of 24 items was administered online using Qualitrics.com and face-to-face. The survey link was emailed to currents and former students in University of Reading, UK and the University of Ghana, members of the British Computer Society Berkshire Branch committee members and email contacts in my address back. In addition, various social media channels such as Facebook, LinkedIn and WhatsApp platforms were used to promote the survey link. The online survey was supplemented by face-to-face data collection where the researcher printed and administered hard copies of the questionnaire to potential respondents during research seminars, workshops and other gatherings. The completed questionnaire collected through face-to-face were coded and captured in MS Excel 2016 and saved as comma separated vale (CVS) file that was later merged with the pre-coded data responses obtained from the online survey mounted on Qualtrics.

4.6.6 Data Analysis and Results

A total of 263 usable responses from an online survey (out of 302 responses) were used for the SEM analysis. The questionnaire was made of three main constructs namely context-based object (CBO), human factors (HF) and data quality (DQ). CBO was measured with 7 items namely "what", "who", "when", "where", "how", "why" (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007) and "situation" (Sowa 2003); whilst DQ was measured with four items namely completeness, unambiguous (Wang & Strong 1996), correctness (Karimi et al. 2004; Wang & Strong 1996) and meaningfulness (Ravichandran & Rai 1999). The human factor was measured by a 26-item individual culture scale, the CVSCALE (Yoo et al. 2011) which was initially developed by Hofstede (Hofstede et al. 2001) as shown in Fig. 4.12. The main constructs for HF namely power distance (PD) and uncertainty avoidance (UA) each had 5 items; long-term orientation (LO) and collectivism (CO) each had 6-items and gender orientation (GO) had 4-items. All the items were measured on a 7-point Likert scale. The questionnaire also had a section on the demographic profile of the respondents.

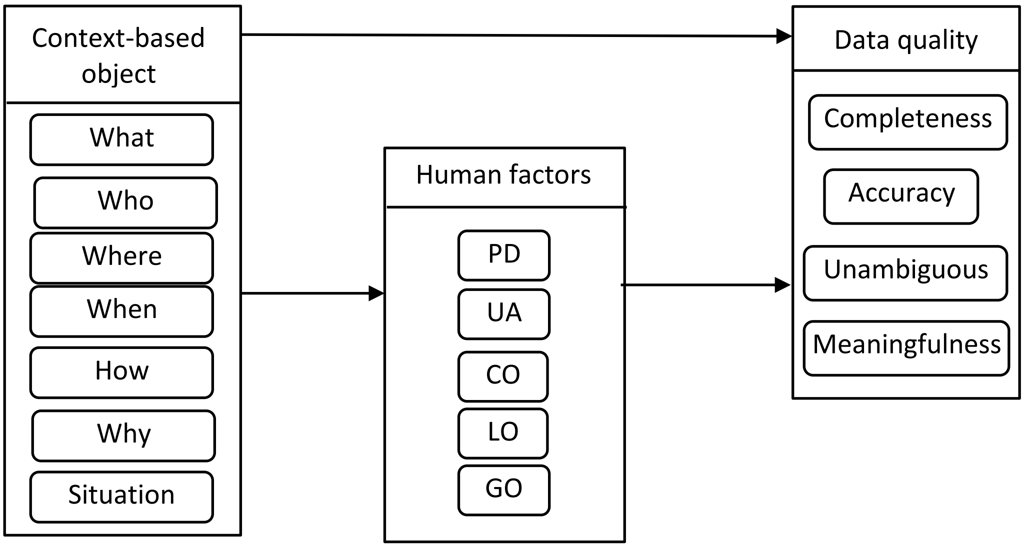


Figure 4.12: Detailed Model of the Context-based data interface

The entire dataset was cleaned to ensure reliability, consistency and validity of the responses. Depending how each respondent completed the questionnaire, some partial responses were used whilst other were discarded. Although the data was screened, all the respondents met the minimum requirements of 18 years + and have ever used IS/IT systems or devices for data, information and knowledge activities. Therefore, no respondent was disqualified based on the set criteria. The data (i.e. the pre-processed file in CSV) was then imported into SmartPLS for structural equation modelling. The measurements and constructs were defined, models were created and the PLS algorithm was run to assess the model measurements and conduct the relevant path analysis.

The profile of the respondents showed male and female proportions of 50.6% and 49.9% respectively. The majority of the respondents were in the 20-29 (54.6%) age group and had first degree educational qualifications (65.5%). The proportion of students among the respondents was 53.7% with the remaining 46.3% in full time employment. For the respondents who were working, most of them were in the finance and retail industries occupying management level positions. The average length of service of those working was 8.5years, mostly in the services sector (48.6%).

4.6.7 Assessment of the measurement model

Using exploratory factor analysis (EFA), the measurement model fit was assessed before path analysis was used to ascertain the significance of the relationship between context-based data (CBO) and data quality (DQ) with human factor (HF) as the mediator as shown in Fig. 4.13.

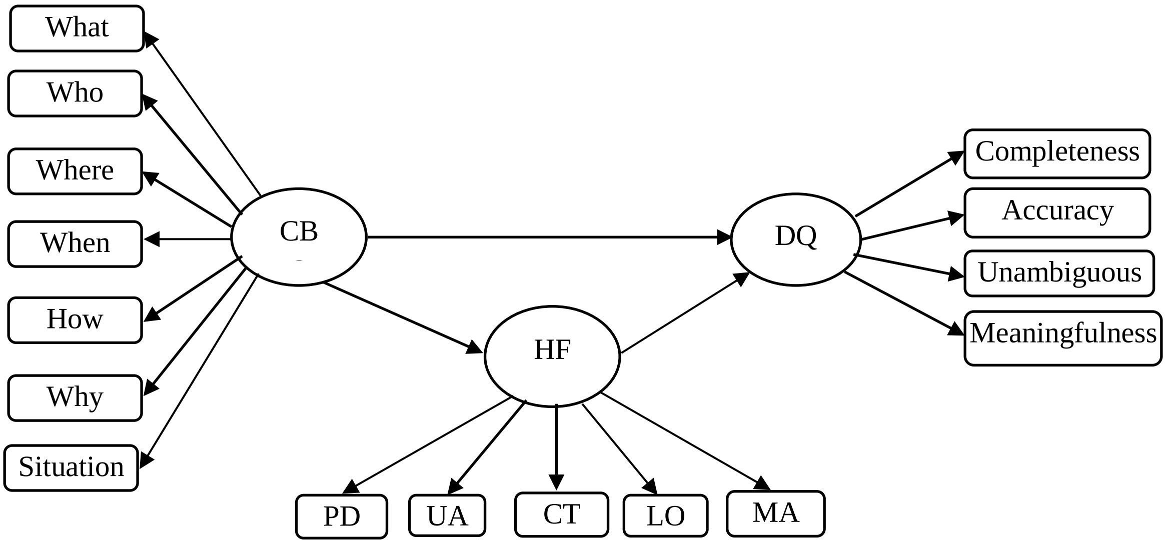


Figure 4.13: Model of the relationship between CBD and DQ

Multicollinearity diagnostics test was carried out on the constructs with second order items (Table 4.2).

Table 4.2: Multicollinearity diagnostics test for the second-order variables

Constructs	VIF	Tolerance
UAD1	3.66	0.27
UAD2	4.24	0.24
UAD3	3.79	0.26
UAD4	2.88	0.35
UAD5	2.26	0.44
COD1	4.21	0.24
COD2	4.85	0.21
COD3	4.69	0.21
COD4	4.36	0.23
COD5	4.12	0.24
COD6	3.25	0.31
LOD1	2.48	0.40
LOD3	3.07	0.33
LOD4	2.12	0.47
LOD5	3.08	0.33
LOD6	2.53	0.40

Through iterative runs of the PLS algorithm and assessment of the outer loadings and the average variance extracted (AVE), two latent variables and some items of were dropped from the initial five latent variables (PD, UA, CO, LO and GO). Thus, all items for PD and GO together with one item from LO were dropped leaving 16 items from the initial 26-items for the multicollinearity diagnostics test. The variance inflation factor (VIF) values observed for the model ranges between 2.12 to 4.85, which indicates acceptable values based on the proposed benchmark i.e. VIF < 5. In addition, the related tolerance values, which ranged from 0.21 to 0.47, were also within the recommended threshold values i.e. tolerance > 0.1 (Howitt & Cramer 2011). Therefore, the model did not pose any multicollinearity issues. The analysis of the measurement model involved the evaluation of the reliability and validity of 38 items for the six distinct latent variables (data quality, context-based data, uncertainty avoidance, collectivism, and long-term orientation).

Table 4.3:Factor loadings of the latent variables for CBO, IF and DQ

Items/ Latent variables	CBO	COD	DQ	LOD	UAD
CBO1	0.80				
CBO2	0.81				
CBO3	0.85				
CBO4	0.86				
CBO5	0.86				
CBO6	0.74				
CBO7	0.98				
COD1		0.87			
COD2		0.90			
COD3		0.90			
COD4		0.89			
COD5		0.89			
COD6		0.85			
DQ1			0.75		
DQ2			0.91		
DQ3			0.91		
DQ4			0.88		
LOD1				0.84	
LOD3				0.88	
LOD4				0.82	
LOD5				0.88	
LOD6				0.84	
UAD1					0.88
UAD2					0.91
UAD3					0.91
UAD4					0.86
UAD5					0.83

All the items (in Table 4.3) loaded very well on the dependent variable with standardized factor loadings greater than the suggested benchmark value of 0.50 (Hair et al. 2010; Ain et al. 2016).

The reliability of the measurement constructs was assessed through Cronbach alpha and composite reliability methods. The results (Table 4.4) show that the Cronbach's alpha values ranged from 0.89 to 0.94, which were greater than the recommend target of 0.70 (Churchill 1979; Ain et al. 2016;

Chong et al. 2018). Also, the values of the composite reliability for the linear relationship between constructs ranged from 0.92 to 0.96, which were all greater than the recommended 0.70 (Ain et al. 2016; Chong et al. 2018). Therefore, reliability of the measurement constructs was confirmed.

Table 4.4: Reliability and validity test results

Constructs	Cronbach's Alpha (>0.70)	rho_A	Composite Reliability (CR) >0.70	Average Variance Extracted (AVE) >0.50
CBO	0.93	0.94	0.95	0.71
COD	0.94	0.95	0.96	0.78
DQ	0.89	0.89	0.92	0.75
HF	0.94	0.94	0.95	0.54
LOD	0.91	0.91	0.93	0.73
UAD	0.93	0.93	0.94	0.77

The validity of the measurement constructs was ascertained using convergent (Average Variance Extracted) and discriminant (Fornell-Larcker) validity tests (Chong et al. 2018). The Average Variance Extracted (AVE) values obtained ranged between 0.54 and 0.78 (Table 4.4) against the recommended threshold of > 0.50 (Fornell & Larcker 1981; Ab Hamid et al. 2017; Chong et al. 2018). The values of the construct's correlations are below the values of the constructs' square root (Table 4.5).

Table 4.5: Results of Fornell-Larker Criterion for discriminant validity

Constructs	CBO	COD	DQ	HF	LOD	UAD
CBO	0.85					
COD	0.27	0.89				
DQ	0.77	0.31	0.87			
HF	0.49	0.78	0.54	0.73		
LOD	0.48	0.50	0.59	0.88	0.85	
UAD	0.48	0.48	0.47	0.87	0.73	0.88

Also, the cross loadings of the constructs (Table 4.6) were above the recommended threshold of 0.707 (Ab Hamid et al. 2017; Chong et al. 2018). Therefore, discriminant and convergent validities were confirmed.

Table 4.6: Cross Loadings of the latent variables

Items of the latent variables	CBD	COD	DQ	HF	LOD	UAD
CBD1	0.80	0.22	0.57	0.40	0.40	0.38
CBD2	0.81	0.24	0.61	0.47	0.48	0.48
CBD3	0.85	0.18	0.64	0.37	0.38	0.37
CBD4	0.86	0.17	0.70	0.39	0.41	0.42
CBD5	0.86	0.25	0.72	0.42	0.42	0.40
CBD6	0.74	0.29	0.59	0.37	0.31	0.34
CBD7	0.98	0.27	0.74	0.46	0.44	0.45
COD1	0.21	0.87	0.25	0.67	0.43	0.39
COD2	0.25	0.90	0.31	0.71	0.47	0.42
COD3	0.26	0.90	0.30	0.73	0.48	0.47
COD4	0.24	0.89	0.27	0.72	0.46	0.48
COD5	0.25	0.89	0.24	0.68	0.41	0.42
COD6	0.23	0.85	0.24	0.62	0.39	0.33
DQ1	0.68	0.26	0.75	0.40	0.42	0.34
DQ2	0.69	0.26	0.91	0.48	0.53	0.43
DQ3	0.68	0.26	0.91	0.51	0.56	0.47
DQ4	0.63	0.28	0.88	0.47	0.51	0.39
LOD1	0.49	0.41	0.51	0.77	0.84	0.71
LOD3	0.45	0.41	0.55	0.77	0.88	0.65
LOD4	0.42	0.40	0.50	0.71	0.82	0.58
LOD5	0.36	0.49	0.51	0.77	0.88	0.58
LOD6	0.34	0.42	0.42	0.73	0.84	0.59
UAD1	0.45	0.35	0.43	0.74	0.63	0.88
UAD2	0.47	0.40	0.44	0.79	0.68	0.91
UAD3	0.42	0.45	0.41	0.80	0.66	0.91
UAD4	0.39	0.47	0.42	0.79	0.66	0.86
UAD5	0.39	0.42	0.37	0.72	0.57	0.83

The results for the full collinearity test showed VIF values ranged between 1.00 and 1.31 (Table 4.7). Thus, lateral collinearity was not a major concern of this study. Also, since the VIF values of all the latent constructs are lower than 3.3 (Chong et al. 2018), the model does not suffer significantly from common method bias.

Table 4.7: Full collinearity test results

Constructs	VIF Values
Data quality (DQ)	1.31
Context-based object (CBO)	1.00
Human factors (HF)	1.31

Overall, all the assessment of the measurement model did not reveal any significant concerns on the reliability and validity of the measurement. Therefore, the measurements are considered fit for modelling the relationship between the constructs.

4.6.8 Assessment of the structural model (path analysis)

The structural model was first assessed to see if the data fit the model and the significance of the relationships between the constructs. The results revealed that the model was significant in establishing a relationship between the constructs (R^2=0.63, $p<0.05$). Thus, a good fit was achieved between the data and the structural model. The significance of the relationship between the constructs was then assessed through path analysis (Fig. 4.14 and Table 4.8).

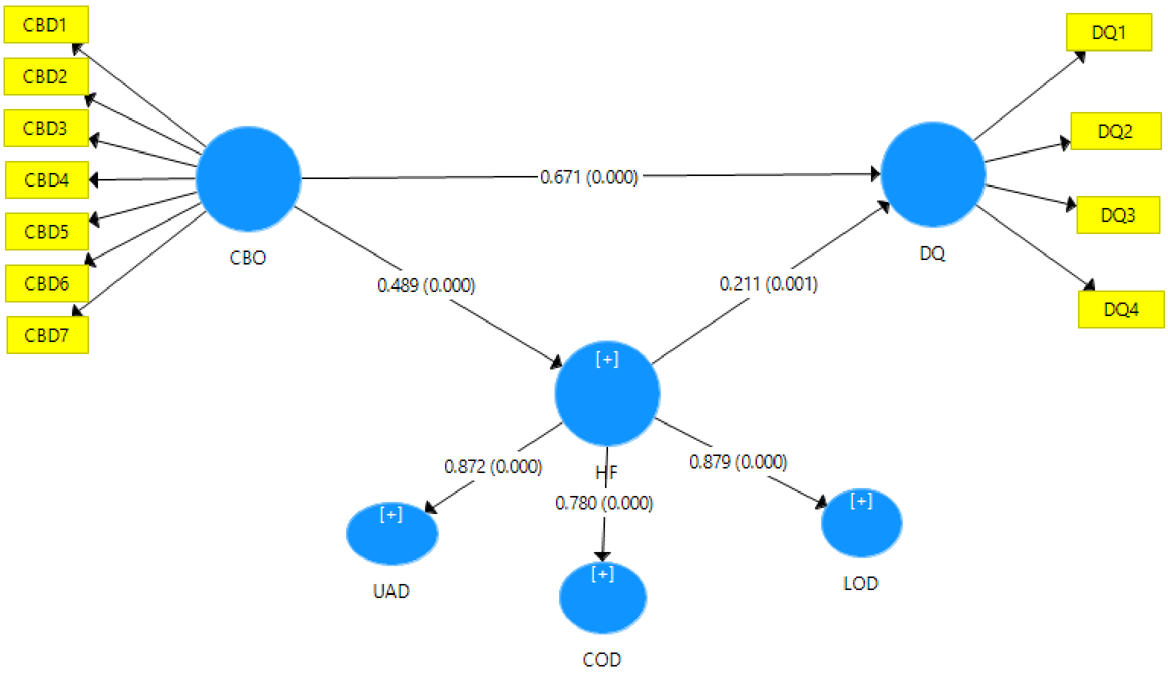


Figure 4.14: Output of the CBO and DQ Model

The results of the path analysis showed a significant relationship between context-based data and data quality (β=0.67, $p<0.05$). Also, human factors (β=0.21, $p<0.05$) especially uncertainty avoidance, collectivism and long-term orientation exhibited significant impact on data quality.

Table 4.8: Path coefficients for CBO and DQ with HF as mediator

Paths	Original Sample (O)	Sample Mean (M)	Stand Dev (STDEV)	T Statistics (|O/STDEV|)	P Values
CBO -> DQ	0.67	0.67	0.06	11.68	0.00
CBO -> HF	0.49	0.49	0.06	7.87	0.00
HF -> DQ	0.21	0.21	0.06	3.49	0.00
CBO -> HF -> DQ	0.10	0.11	0.04	2.82	0.00

There was a significant mediation effect of HF (β=0.10, $p<0.05$) on the relationship between CBO and DQ (Table 4.8), however, given that the direct relationship between HF and DQ (β=0.21; $p<0.05$) and CBO and DQ (β=0.67, <0.05) are also significant; the resultant amount of mediation works out to 31.3%. There is therefore partial mediation effect of HF on the relationship between CBO and DQ.

4.6.9 Discussion

The objectives set at this stage of the study were accomplished. A context-based data model for IS/IT system has been established. Also, the perceived value of context and the significance of the individual items that constituent context-based data has been affirmed. The moderating effect of human factors in terms of individual culture was also affirmed. The proposed relationship between context-based data and quality of data was examined and the structural paths were found to be significant.

The data for the study revealed significant relationship between context-based data and data quality ($\beta = 0.067$, $p < .05$). This means that the respondents' belief that if adequate context is stored with data in an IS/IT system, it will enhance the quality of the data. The results have implications for data management practices and reiterates the call for new mandate and pragmatic approaches to data management worldwide (Tenopir et al. 2011). Contributing to the debate about lack of context in organisations data (Cappiello et al. 2003) used to generate insightful business analytics, Anderson (2015) recommended the "collect all the things" and then "join the dots" approach to data collection. It is, however, important to give considerations to other context factors given that Tenopir et al. (2011) reported significant differences and approaches in data management practices with respect to work schedule, age and geographical location. The lack context in stored data was evident in situations where human actors (Tenopir et al. 2011) or systems such as IoT or sensors (Croll 2015; Shah & Chircu 2018) are used to capture the data into the system.

The result of the study shows that culture affect data quality and individual differences mediate the effect of context on the quality of data stored in an IS/IT system. The observation by Tenopir et al. (2011) that barriers to effective data management are deeply rooted in institutional and individual culture was evident from this study. A significant relationship was observed between individual culture (human factors) and data quality ($\beta = 0.21$, $p < .05$). The results clearly indicate that individual culture affect data management practices such as data storage and sharing (Tenopir et al. 2011).

4.6.10 Theoretical and practical implications

Studies (e.g. Anderson 2015; Tenopir et al. 2011, Cappiello et al. 2003, etc) have highlighted the issue of lack of context in stored data in IS/IT systems, however, there is a lack a framework that establishes the elements of context-based data and how this impact on the quality of stored data in IS/IT systems. The theoretical contribution of this study is a framework for the design of context-based data interfaces for IS/IT systems (Fig. 4.8). The methodological contribution is the use of the elements of Zachman's (1987) and evidence from context-aware literature (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003); ubiquitous computing and information systems programming and interface design techniques as analytical framework to identify the components of context whilst defining the concept of context-based data.

This study highlights the importance of building context into data interfaces in IS/IT systems. The type of context details suggested include the "why" (Anderson 2015); "where" (Tenopir et al. 2011), ""who, what, where, when" (Lambert and Writer 2018); all of which are consistent with the elements identified by Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007); Sowa (2004); and also Zachman's (1987) information system architecture framework. The results also suggest that pragmatic approaches to data management are imperative and individual differences are critical factors to consider when it comes to storing data in IS/IT systems.

The practical implications of the results for organisations are in the areas of personnel management especially hiring and assigning job responsibilities to data and information professionals. Managers will find the modified CVScale (Yoo et al. 2011; Hofstede et al. 2001) for information activities useful in assessing the individual cultural orientations of their personnel in order to hire and assigned them those data and information management tasks that fits their personality and helps them to achieve optimum job outputs.

4.7 Evaluation

The results provide new insights on components of context that should be built into the data interface of IS/IT systems. However, context is a multi-faceted and could have many more components depending on the environment and the phenomenon for which the data is being captured. The defined elements of context-based data may therefore be limited. In addition, the interview responses revealed that each of the context elements could also be multi-faceted example, the "who" about data may involve several people within the workflow in an organisation. Therefore, the scope of the study could be extended by applying the framework in business setting and consideration given to those other dimensions of the context items identified in this study. In addition, it would be worth validating the framework in different geographical settings and cultures (and levels organisation and national culture) since culture was found to have a huge impact on data management activities. There is also the need to extend the framework to the information or semantic level to ascertain the prospects of designing context-based information interfaces for IS/IT systems which will support the retrieval of context-based data for information activities.

4.8 Conclusion

This section drew on syntactic components of semiotics, and elements of Zachman's (1978) Framework for Information Systems Architecture to study the antecedences of the quality of data stored in IS/IT systems from the point of view of users. The lack of context in the ontology of data as a key ingredient in IS/IT systems at the syntactic level is highlighted whilst introducing a model that demonstrate the interrelationship between context-based data and data quality with individual culture as a mediation factor.

The model has been validated though measurement and structural model fits. The results showed a significant relationship between context-based data and the quality of data stored in an IS/IT system. The indications are that the quality of data found in IS/IT systems could benefit from storing more context details (such as "why", "how", etc.) about the phenomenon the sign (data) represents. Furthermore, individual culture had a significant impact on the quality of data stored in IS/IT systems and mediate the relationship between context-based data and data quality.

On the effects of culture on data storage and information retrieval from IS/IT systems, although factors that affect data storage in IS/IT systems have been explored, there is as yet no evidence of a study which contextualises culture and specifically uses Hofstede individual cultural scale as a mediating factor to explore data storage and retrieval of information from IS for knowledge activities. This study therefore makes a unique contribution to literature by adopting and adapting the CVScale to IS context. This study also argues that data stored in IS/IT systems as a "sign" originates from and impact on the social environment, therefore context and impacts could be used as key metrics for assessing the characteristics and quality of human information interaction and interface outputs.

4.9 Chapter Summary

In this chapter, a mixed method approach is used to establish empirical evidence of the main research problem whilst addressing two key objectives. The main research problem was missing context in stored information in IS/IT systems and the first two objectives were –1) determine the sources of missing context and information gaps in stored information in computer-based systems? and 2) ascertain how human factors (individual culture) influence data storage and information retrieval from computer-based systems.

Using the content of an eLearning course as proxy for information system, and data from participants at the end of an eLearning course in statistics was analysed together with interviews with development team of the eLearning course content. The findings from study revealed inadequate capture of context in the content of the eLearning course stored in the leaning management system (LMS). This study thus highlighted missing context or information gaps in stored information in information systems. The context issues identified included but not limited to culture, non-localised, non-exhaustive information, information dissymmetry, etc.; in a way reflects the pragmatic and social context issues related to the "why", "how" and "situation" of the stored content. These affected understanding or semantics of the stored eLearning content among several actors in the interaction process.

A conceptual model was developed from the preliminary study and interviews were subsequently used to collect additional data leading the development of a context-based data interface (CBII) model. Furthermore, data from a questionnaire survey was used to validate the model to complete the first iteration in the form of a CBII framework. The CBDI framework help to address two other objectives of the study, that is 3) how can users' pragmatic needs and social context be incorporated into the data, information and knowledge interfaces of computer-based information systems? and 4) does a context-based human information interface framework enhance the usability of information from computer-based systems for knowledge activities?

The outcome of this chapter only addresses the issues at the syntactic layer. There is the need to develop and validate a similar framework at the semantic level. The next chapter therefore uses results from interviews to refine the CBDI into CBII model, which is then validated with quantitative survey data.

Chapter 5
Context-Based Information Interface Model

5.1 Introduction

In this chapter, the initial model from the case studies in the previous chapter is refined through further analysis of data and case studies to arrive at the HII framework. In order to achieve the main aim of investigating how human information interface impact on knowledge activities, this chapter provides answers two objectives of the study, i.e. 1) how can the designs of information systems effectively incorporates users' pragmatic needs and social context into the information interface?; and 2) how can pragmatic and social context be built into the information interface to enhance the usability of information retrieved from IS/IT systems?.

Interviews and surveys are used as instruments to collect and analyse data to support the development and validation of the context-based information interface framework. Thus, the results from the qualitative interviews and quantitative analysis informed the design of the HII framework.

5.2 Towards the design of context-based information interface for IS/IT systems

The attempt to extend the context-based data interface framework requires an approach to the design of context-based information interfaces for IS/IT systems. First, in-depth qualitative interviews are conducted, and the results are used as a basis to propose a CBII model (see interview protocol in Appendix 5). Then, quantitative survey is used to validate the model by testing the relationship between context-based data and quality of information retrieved from IS/IT systems. In the next section, the method and procedure used for analysis, responses from the interview and discussion of the development of the CBII model are presented.

5.2.1 Method and Procedure

The method and data analysis procedure used for the qualitative interviews in this section were similar to those in Chapter 4 section 4.4.1. Qualitative interviews generated some insights to help extend the context-based data interface framework into a context-based information model. The interviews were conducted face-to-face and via video calls on skype for interviews who were outside the UK. The questions were structured around intelligent information interfaces, relevance of context details for users and the prospects of developing context-based information interfaces. Although, it was a structured interview, where necessary additional questions were asked to gain good insights on the issues. The interview sessions lasted between 35- 55minutes in some cases. The interviews were recorded and transcribed and the recordings replayed several times for the purpose of cross-checking and ensuring accuracy. The data analysis procedure followed the thematic analysis process (Braun & Clarke 2006) and accomplished using NVivo 10 software. The responses from the interviews are analysed and presented under prior themes in the next section.

5.2.2 Responses from the interviews

Are current information interfaces of IS/IT systems intelligent? If not, why and how does this affect the quality of data we retrieve from IS/IT systems for information activities?

> *"No, I don't think current interfaces are intelligent enough, they do not necessarily allow us to retrieve as much details about data, information or events"* (Change Management and Data Protection Officer, Shipping Company, UK).

> *" …they can be programmed to be intelligent, but for now, no, I don't think current interfaces of IS have triggers to induce the context details you are talking about". (*Software Engineer, Consulting Firm, Chile).

> *"No, and yes, as it depends on what the system is design for as well as 'mental restrictions' of designers since they cannot incorporate all possible outputs required in a single interface". There are however some intelligent retrieval interfaces that that be customised based on changing user needs"(*BI Analyst and Solutions Architect, Consulting, UK).

> *"Not actually….not designed in terms of context but based on frequency and statistical properties which helps to visualise, create relationships and bring some basic intelligence to bear. However, recent decade interfaces are intelligent using AI, web of knowledge and semantic models".* (Research Scientist, NHS, UK).

The interviewees also expressed their opinion on the effect of lack of context on the quality of information stored in IS/IT systems.

> *"As to whether this affects the quality of information, I will say yes, the quality of information is affected since that depends very much on context and human understanding and interpretation."* (BI Analyst and Solutions Architect, Consulting, UK).

> *"Yes, of course, the quality of information currently stored in IS/IT systems suffer from inadequate context. However, recent AI interfaces are designed with the know how to store and retrieve focused information or key variables for specific purposes"* (Research Scientist, NHS, UK).

From the responses, it was clear that the current information interfaces of IS/IT systems are not necessarily intelligent although some search features, retrieval agents have been designed to generate outputs that show some statistical properties. Current information interfaces are design for user-friendliness, user experiences and limited outputs specifications.

The opinions of the interviewees were sought on the prospects of building more context into the information interface of IS/IT systems. In response, all the interviewees affirmed the potential impact of the availability of more context when data is retrieve from IS/IT systems for information activities. Their responses suggest that this will enhance user's ability to interpret, understand and use the data for information activities.

> "*….being able to retrieve the statistical properties of data or details such as "how" and why" are key for understanding the data, building predictive models and interpreting the outputs".* (Research Scientist, NHS, UK).
>
> "*it is all about programmability, once it is possible to store the context text-details, it becomes even more easier to design the information interface to retrieve what has been stored. Definitely, more context details would enhance users understanding of data".* (IT Manager, Financial Market, Ghana).
>
> *" once the context details have been stored, it is possible to access these through machine learning. Deep learning in particularly would find the context details very useful. It would also enhance the output from NLP as more contexts become available".* (BI Analytics Consultant, Consulting Firm, UK).
>
> *"…….surely being able to retrieve more contexts (especially "why" and "how") will enhance the ability of machines and users to understand the data retrieved from IS/IT systems."* (Software Engineer, Consulting Firm, Chile).

It can be gleaned from the responses that the interviewees had positive outlook about the prospects of building more context into the information interface of IS/IT systems. Some of interviewees however acknowledge some challenges including but not limited to possible information overload and dealing with real time changes in some of the context details such as time, location, etc. based on the purpose of use. The implications of context-based interface in terms of user-friendliness, interactivity, on-screen display options for the outputs and user experience were also highlighted.

The following are the main findings from the interviews:

i. the information interface for most IS/IT systems are not necessarily intelligent
ii. context details such as "what", "who", "when", "where", "how", "why" Woo, and "situation" about data retrieved from IS/IT systems would enhance users ability to interpret, understand, use and add value to the data

iii. users could benefit from the availability of context-based details when data is retrieved from IS/IT system for information activities

iv. context interface would enhance the predictive and learning ability of machines and users.

5.3 Building Context into Information Interface

The process of extending the context-based data interface framework into a context-based information interface model was informed by the assumption that output must match input. Therefore, whatever features were built into the data interface of IS/IT system to support the storage of those context details about an object or event must equally be incorporated into the retrieval interface to ensure similar output. The design of context-based data interface earlier provides the foundation for this information interface. That is the context-based data interface would have allowed for the storage of context -based details such as "why', "how", "where", "when", "who" and "situation" in addition to the "what" about an object in the environment, and the retrieval interface should enable same. The ability to retrieve those context-details about and object/event, would allow users to interpret, understand, use, add value to data (Chang & King 2005) build and interpret predictive models. This is shown as the semantic layer of the iterative framework in Fig. 5.1 (circled part).

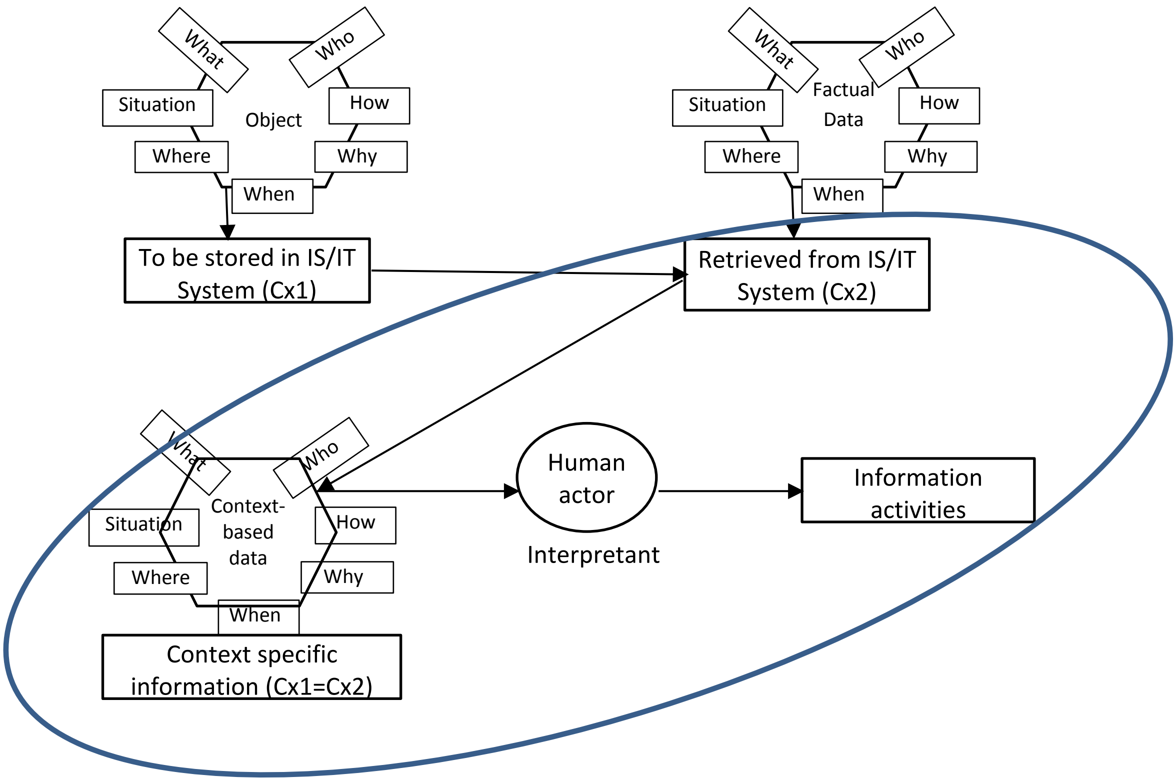


Figure 5.1: Mini artefact 2 - Context-based information interface framework

The context-based data interface has been extended into a CBKI by showing how the outcome of the retrieval of factual data should results in stored knowledge in IS/IT systems (i.e. context-informed explicit knowledge) which could be leveraged by users to engage in context-specific knowledge activities. Features of the retrieval interface should potentially include some level of intelligence settings that should enable users to retrieve the context-based data to enhance their understanding of information.

The next section provides proof of the significance of CBD for information activities by validating the relationship between CBD and quality of information. Data would be analysed to ascertain if there is a significant relationship between CBD and quality of information; and whether individual culture and interface factors have any significant mediation effect on the relationship between CBD and quality of information.

5.4 Validating the Context-based Information Interface (CBII) framework

This section reports the outcome of the validation of the proposed relationship between individual culture, interface factors (Stamper 1973; Liu 2000) on human information interaction and information quality (Chang & King 2005). Interface factors related to pragmatics such as intentions (Hawizy et al. 2006; Blandford & Attfield 2010), usability (Abran et al. 2003; Ong & Lai 2007), and acquisition (Barron et al. 1999; Kraaijenbrink & Wijnhoven 2006) are considered as factors which affect the quality of the information object and information activities (Lin et al. 2009). Thus, semiotics has been explored as principles and methods of designing user interface (Connolly & Phillips 2002; Hawizy et al. 2006; Sjöström & Goldkuhl 2004).

Semantic factors such as mapping of information (Price & Shanks 2004; Liu 2000; Sjöström & Goldkuhl 2004) to and from real world situations, and understanding or meanings (Chandler 2000; Liu 2000) also affect the quality of interaction and information activities. The social environment (Liu 2000) serves as a basket for establishing the context and the impact of human information interactions and activities (Byström & Hansen 2005; Olsen Jr. 2010; Pettigrew et al. 2001). Although the syntactic factors also impact human information interaction (Van der Veer & Van Vliet 2001), it was not considered in this case study as the information object was already stored in an IS. The purpose of this study was to ascertain whether human factors (individual culture) affects information quality; and whether the interface factors in any way has impact on information activities (proxy for information object) in line with Marchionini's (2008) suggestion to examine both the human and information entities in interaction studies.

In this section therefore, structural equation modelling is used to assess the nature and significance of the relationship between context-based data, human actor, interface factors and information object. Context-based information (CBI) was derived from literature ((Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003). Human actor or human factors (HF) was represented by individual culture (Yoo et al. 2011; Hofstede et al. 2001); whilst interface factors (IF) was represented by semantic components (Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006). Information quality (Chang & King 2005) was used as a proxy for information object (Fig. 5.2).

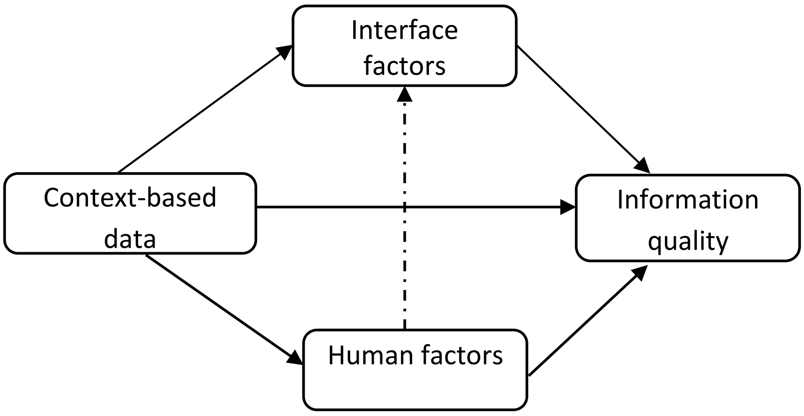


Figure 5.1: General Model of the Context-based information and information quality

The aim of this modelling was to provide proof of the relationship between the constructs and to inform the development of the context-based information interface framework. The model assumes a relationship between context-based data and the quality of information stored in IS/IT systems. In addition, human factors and interface factors were assumed to impact on the quality of information and in addition mediate the relationship between context-based information and information quality.

5.4.1 Methods and Procedure

The methods and data analysis proceeded used are similar to the one in Chapter 4 section 4.4.1. Questionnaire survey was used to collect data for validating the relationship between context-based data and information quality. The questionnaire had four sub-sections namely information quality, interface factors, individual cultural orientation towards data storage, and a section on context-based data (Table 5.1). The remaining sub-sections were cultural orientation towards information retrieval, information quality, context-based information, knowledge quality and quality of knowledge activities.

Table 5.1: Constructs used in the SEM questionnaire

Constructs	Items	Source
Information Quality	Interpretable, useful, understandable, add value	Chang & King (2005)
Context-based data (CBD)	Who, why, where, when, how and what	Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007)
	Situation	Sowa (2004)
Interface factors	Quality of mapping, level of interpretation	Marchionini (2008); Barron et al. (1999); Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Individual culture	Power distance, collectivism, uncertainty avoidance, long-term orientation, masculinity	Yoo et al. (2011)

There was also a section on demographic characteristics of the respondents. The key constructs, items and sources of the questions are shown in Table 5.1. The measurements (Olivier 2004; Oates 2006; Zikmund et al. 2013) for the items were carefully developed after critical review of literature and similar instruments by assigning numbers in a reliable and valid way to each of the items on a 7-point Likert-scale (Oates 2006; Olivier 2004; Zikmund et al. 2013). The questions in all the questionnaires used were very brief, unambiguous and easy to answer (Rogers et al. 2011; Myers 2009) and this helped to achieve a high response rate. The items in the questionnaires were tested for reliability and validity (Straub et al. 2004; Venkatesh & Brown 2013).

5.4.2 Measurement development and data collection

In this round of the survey, a total of 258 responses obtained from an online survey were used for the analysis. The questionnaire was made up of four main constructs namely context-based information (CBI), interface factors (IF), human factors (HF) and information quality (IQ) as shown in the detailed model of the relationship between the constructs is shown in Fig. 5.3. CBI was measured with 7-items namely "what", "who", "when", "where", "how", "why" (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007) and "situation" (Sowa 2003). IQ was measured with four items namely interpretability, usefulness, understandability and value addition (Chang & King 2005). Semantics was measured by a total of 6-items, 3 each for level of mapping and quality of mapping (Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006) whilst human factor was measured by a 26-item five-dimensional scale of individual cultural values, the CVSCALE (Yoo et al. 2011).

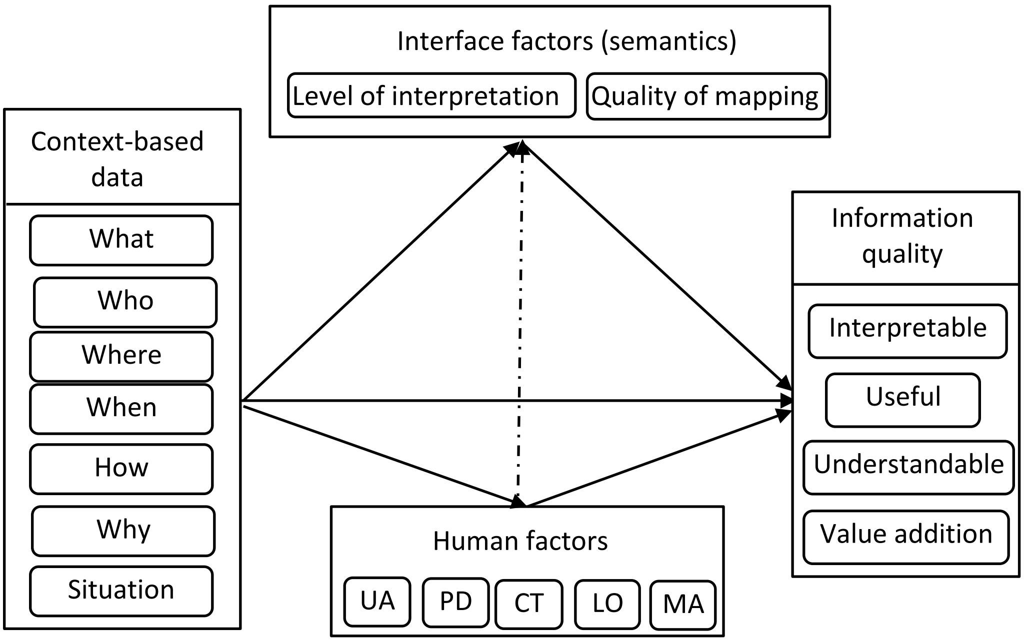


Figure 5.3: Detailed Model of the Context-based Information Interface

The measurement items were all anchored on a 7-point Likert scale. The last section of the questionnaire solicited for demographic information of the respondents.

5.4.3 Data Analysis and Results

The respondents were made up of 51.6% males and 48.4% females. The majority of the respondents were in the 20-29 (54.6%) age group. Most of the respondents (64.3%) had attained at least undergraduate level education. The respondents were made up of both students, unemployed and those in full time employment, with 46.3% being employed in various industries. The average length of service of those working was 8.5years, mostly in the services sector (48.6%).

5.4.4 Assessment of the measurement model

The measurement model fit was assessed using exploratory factor analysis (EFA). This helped to ascertain the significance of the relationship between context-based information, (CBD) and quality of information (QOI) with human factors (HF) and interface factors (IF) as mediators. The path coefficients and R-square values were useful in determining the nature, magnitude and significance of the relationship between the constructs at the 0.05 level of significance. A model of the relationships between the constructs are shown in Fig 5.4.

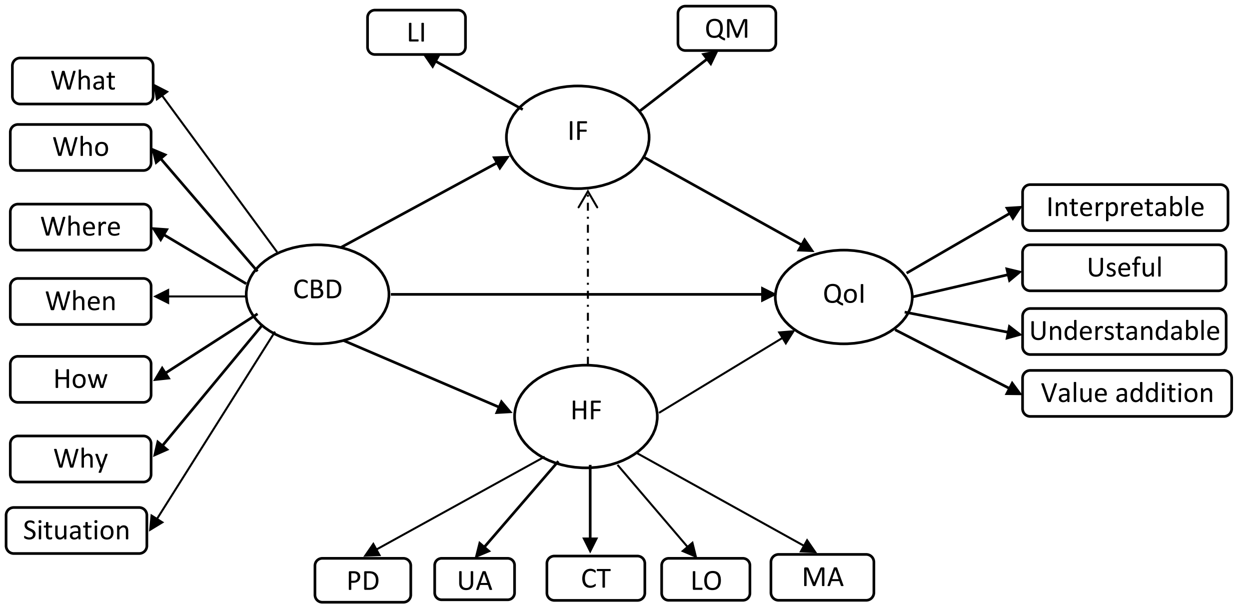


Fig. 5.4: Model of the relationship between CBD and QoI

To avoid overfitting, multicollinearity diagnostics test was carried out on the constructs with second order items for HF and IF (Table 5.2). The test results showed that the variance inflation factor (VIF) values observed for the models ranged between 1.598 to 4.692 which less than the acceptable threshold (i.e. VIF <10). Similarly, the associated tolerance values which ranged from 0.161 to 0.469 were above the recommended threshold value i.e. tolerance > 0.1 (Howitt & Cramer, 2011). Therefore, multicollinearity was not an issue of great concern in this model.

Table 5.2: Multicollinearity diagnostics test for the second-order items

Constructs/ items	VIF	Tolerance
COI1	3.488	0.349
COI2	3.209	0.321
COI4	3.829	0.383
COI6	3.032	0.303
LI1	3.083	0.308
LI2	2.721	0.272
LI3	2.417	0.242
LOI1	1.875	0.188
LOI3	2.626	0.263
LOI4	2.565	0.257
QOM1	1.598	0.160
QOM2	1.610	0.161
QOM3	1.733	0.173
UAI1	2.920	0.292
UAI3	3.845	0.385
UAI4	4.692	0.469
UAI5	4.213	0.421

The measurement model was assessed for reliability and validity of the items for eight distinct latent variables (information quality, context-based information, power distance, uncertainty avoidance, collectivism, long-term orientation and masculinity, interpretability and quality of mapping).

All the items loaded very well on the dependent variable (Table 5.3). The standardised factor loadings were greater than the suggested yardstick of 0.50 (Hair et al. 2010; Ain et al. 2016).

Table 5.3: Factor loadings of the latent variables for CBI, IF, HF and QOI

Items/latent variables	CBI	CO	QOI	LI	LO	QM	UA
CBI1	0.794						
CBI2	0.884						
CBI3	0.878						
CBI4	0.872						
CBI5	0.894						
CBI6	0.817						
CBI7	0.985						
COI1		0.914					
COI2		0.893					
COI4		0.919					
COI6		0.882					
IQ1			0.879				
IQ2			0.905				
IQ3			0.923				
IQ4			0.856				
LI1				0.925			
LI2				0.904			
LI3				0.895			
LOI1					0.860		
LOI3					0.902		
LOI4					0.897		
QOM1						0.842	
QOM2						0.813	
QOM3						0.853	
UAI1							0.893
UAI3							0.920
UAI4							0.937
UAI5							0.928

The assessment of the reliability of the measurement constructs was carried out using the Cronbach alpha and composite reliability methods. The Cronbach alpha values observed ranged between 0.785 to 0.949 (Table 5.4), which were greater than the recommended mark of 0.70 (Churchill 1979; Ain et al. 2016; Chong et al. 2018).

Table 5.4: Reliability and validity test results

Constructs	Cronbach's Alpha (>0.70)	rho_A	Composite Reliability (CR) >0.70	Average Variance Extracted (AVE) >0.50
CBD	0.949	0.952	0.959	0.769
CO	0.924	0.924	0.946	0.814
HF	0.923	0.926	0.935	0.567
IF	0.885	0.890	0.913	0.637
LI	0.894	0.895	0.934	0.825
LO	0.864	0.864	0.917	0.787
QM	0.785	0.790	0.874	0.699
QOI	0.913	0.914	0.939	0.794
UA	0.939	0.939	0.956	0.846

The values of the composite reliability for the direct relationship between the constructs ranged from 0.874 - 0.959, which were all greater than recommended 0.70 (Ain et al. 2016; Chong et al. 2018) as shown in Table 5.4. Therefore, the measurement constructs were confirmed to be reliable.

Table 5.5: Results of Fornell-Larker Criterion for discriminant validity

Constructs	CBI	CO	HF	IF	LI	LO	QM	QOI	UA
CBD	0.877								
CO	0.419	0.902							
HF	0.624	0.378	0.753						
IF	0.300	0.267	0.402	0.798					
LI	0.293	0.234	0.359	0.430	0.908				
LO	0.305	0.476	0.430	0.428	0.377	0.887			
QM	0.251	0.255	0.378	0.498	0.673	0.407	0.836		
QOI	0.667	0.436	0.686	0.346	0.329	0.628	0.301	0.891	
UA	0.541	0.491	0.484	0.325	0.297	0.650	0.298	0.642	0.920

The assessment of the validity of the measurement constructs was established using convergent (Average Variance Extracted) and discriminant (Fornell-Larcker) validity tests (Chong et al. 2018). The observed AVE values ranged between 0.567 and 0.825 (Table 5.10) against the recommended threshold of > 0.50 (Fornell & Larcker, 1981; Ab Hamid et al. 2017; Chong et al., 2018). The values of the constructs' correlations are below the values of the constructs' square root (Table 5.4).

Furthermore, the cross loadings (Table 5.6) of the principal constructs were above the recommended threshold of 0.707 (Ab Hamid et al. 2017; Chong et al. 2018). In effect, discriminant and convergent validities were confirmed for the measurement model.

Table 5.6: Cross Loadings of the latent variables for CBD, IF, HF and QOI

Constructs	CBI	CO	HF	IF	LI	LO	QM	QOI	UA
CBI1	0.794	0.327	0.466	0.298	0.306	0.448	0.232	0.512	0.397
CBI2	0.884	0.382	0.584	0.292	0.273	0.554	0.259	0.607	0.525
CBI3	0.878	0.372	0.528	0.215	0.219	0.503	0.169	0.567	0.451
CBI4	0.872	0.325	0.519	0.243	0.252	0.528	0.186	0.592	0.454
CBI5	0.894	0.344	0.548	0.266	0.245	0.564	0.241	0.611	0.472
CBI6	0.817	0.408	0.563	0.252	0.237	0.523	0.222	0.542	0.481
CBI7	0.985	0.411	0.608	0.276	0.270	0.583	0.231	0.652	0.530
COI1	0.375	0.914	0.732	0.251	0.238	0.434	0.221	0.413	0.493
COI2	0.361	0.893	0.696	0.213	0.176	0.454	0.217	0.406	0.421
COI4	0.357	0.919	0.694	0.228	0.201	0.399	0.217	0.381	0.435
COI6	0.421	0.882	0.684	0.270	0.229	0.429	0.268	0.371	0.419
IQ1	0.576	0.366	0.584	0.263	0.243	0.533	0.236	0.879	0.553
IQ2	0.538	0.399	0.616	0.304	0.281	0.549	0.273	0.905	0.581
IQ3	0.604	0.395	0.641	0.330	0.318	0.569	0.282	0.923	0.623
IQ4	0.653	0.392	0.600	0.334	0.327	0.584	0.278	0.856	0.530
LI1	0.248	0.216	0.331	0.873	0.925	0.337	0.649	0.291	0.282
LI2	0.247	0.189	0.298	0.815	0.904	0.322	0.558	0.282	0.246
LI3	0.303	0.232	0.347	0.844	0.895	0.369	0.624	0.325	0.280
LOI1	0.504	0.459	0.749	0.376	0.339	0.860	0.348	0.537	0.596
LOI3	0.558	0.415	0.732	0.408	0.358	0.902	0.390	0.594	0.562
LOI4	0.549	0.391	0.725	0.354	0.306	0.897	0.344	0.539	0.571
QOM1	0.237	0.196	0.328	0.800	0.639	0.392	0.842	0.314	0.252
QOM2	0.120	0.201	0.237	0.678	0.465	0.246	0.813	0.139	0.159
QOM3	0.262	0.243	0.374	0.766	0.572	0.372	0.853	0.286	0.326
UAI1	0.549	0.465	0.815	0.319	0.278	0.622	0.307	0.626	0.893
UAI3	0.470	0.455	0.807	0.260	0.243	0.577	0.231	0.564	0.920
UAI4	0.468	0.459	0.816	0.332	0.309	0.573	0.295	0.582	0.937
UAI5	0.505	0.426	0.814	0.285	0.260	0.618	0.261	0.590	0.928

The results for the full collinearity test showed VIF values ranging between 1.198 and 1.785 (Table 5.7). Thus, lateral collinearity was not a major concern of this study. Also, the VIF values of all the latent constructs were lower than 3.3 (Chong et al. 2018), therefore the model does not suffer significantly from common method bias.

Table 5.7: Full collinearity test results

Constructs	VIF Values
Information quality (IQ)	1.198
Context-based data (CBD)	1.645
Human factors (HF)	1.785
Interface factors (IF)	1.637

In all, the assessments of the measurement model did not reveal any significant concerns with respect to the reliability and validity of the measurement model. Therefore, the measurements are considered fit to be used in modelling the relationship between the identified constructs.

5.4.5 Assessment of the structural model (path analysis)

The structural model was assessed to ascertain whether the data fit the model and the significance of the relationships between the CBD and QOI with IF and HF as mediators. The results showed that the model was significant in explaining the variance of the dependent variable, QOI (R^2=0.567, p<0.05). That is, there was a good fit between the data and the structural model. The significance of the relationship between the constructs was also assessed through path analysis (Fig. 5.6 and Table 5.8).

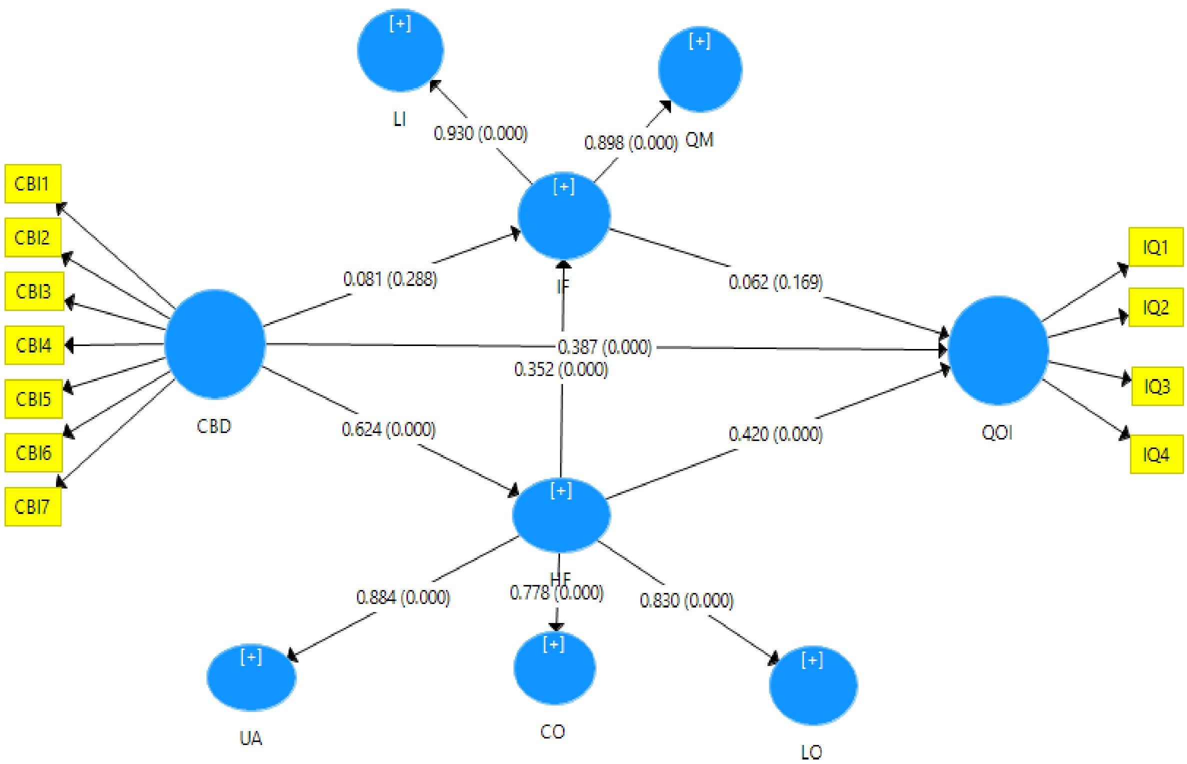


Figure 5.6: Output of the Model for CBI and QOI

The results revealed a significant relationship between CBI and QOI (β=0.387, p<0.05). In addition, HF exhibited significant relationship with both CBI (β=0.642, p<0.05) and QOI (β=0.420, p<0.05).

On the other hand, IF did not show any significant relationship with both CBI (β=0.081, p>0.05) and QOI (β=0.062, p>0.05).

Table 5.8: Path coefficients for CBD and QOI

Paths	Original Sample (O)	Sample Mean (M)	Stand Dev (STDEV)	T Statistics (|O/STDEV|)	P Values
CBD -> HF	0.624	0.626	0.052	12.039	0.000
CBD -> IF	0.081	0.078	0.075	1.075	0.282
CBD -> QOI	0.387	0.382	0.070	5.491	0.000
HF -> IF	0.352	0.355	0.099	3.539	0.000
HF -> QOI	0.420	0.422	0.068	6.171	0.000
IF -> QOI	0.062	0.060	0.045	1.379	0.168
CBD -> HF -> IF	0.219	0.224	0.071	3.105	0.002
CBD -> HF -> QOI	0.262	0.266	0.055	4.731	0.000
CBD -> IF -> QOI	0.005	0.005	0.007	0.715	0.474
CBD -> HF -> IF -> QOI	0.014	0.013	0.010	1.302	0.193

The joint mediation effect of HF and IF (β=0.014, p>0.05) on the relationship between CBD and QOI was not significant (Table 5.8). However, given that the mediation effect of IF (β0.005, >0.05) on the relationship between CBI and QOI was not significant, but that of HF (β=0.262, p<0.005) was, indicates that 98.1% of the mediation effect was due to HF. There was, therefore, full mediation effect of HF on the relationship between CBD and QOI. The results suggest the need for considering context-based information interface and the importance of the human user in achieving quality in information stored in IS/IT systems.

5.5 Evaluation

The structural modelling in this section helped to validate the CBII model and confirm the CBII framework developed in section 5.3. The modelling tested and confirmed a significant relationship between context-based data and the quality of information. Although the purpose of this chapter was to complete the second iteration of the HII framework, the overall HII framework would not be complete without the consideration of the pragmatic level issues. The outcome of the semantic level activities mainly focused on making meaning of data from the syntactic. The product of the semantic layer activities in the form of information artefact (i.e. CBII) should serve as input for knowledge activities at the pragmatic level. Knowledge level activities include ability to create knowledge and adopt, adapt, expand, innovate, leverage and apply the knowledge to different situations. It is therefore, necessary to consider a third iteration to extend the CBII into a context-based knowledge interface framework to cover all three layers of the DIK pyramid and the semiotic levels.

5.6 Conclusion

In this section, the proposed context-based information interface framework has been validated using structural equation modelling. The hypothesis that there will be a significantly positive relationship between context-based knowledge interface (CBII) and quality of knowledge was tested and confirmed. The results from the validation also confirmed the significant mediation effect of individual culture (human factor) on the relationship between CBDI and quality of information.

The data for the study shows that individual culture affect information activities and so does the semiotic factors that lay at the interface between the human user and the information object. The outcome demonstrates how semiotic defined context interface factors affect the ability of users to effectively understand stored data and use it for information (semantic) and knowledge (pragmatic) activities. Therefore, data collection and storage could benefit from improved data and information interface designs that incorporates context to enhance the usability of the stored data and information. This will go a long way to reduce uncertainties and enhance the quality of decision making when information is retrieved from computer-based systems. It is hoped that this approach would also reduce the gap or mismatch between the intentions of the information creator and those of the information user so that decisions made by user will be more accurate, context specific and adaptable to users' pragmatic and social context needs. It is therefore concluded that the design of CBDI could positively enhance the quality of information retrieved from IS/IT systems and its use for knowledge activities.

5.7 Chapter Summary

In this chapter, the context-based data interface model from the studies in chapter four is refined through further analysis of interview and survey data. The purpose of this chapter was to explore further how context can be built into the information interface of IS/IT systems in order to enhance the understanding and usability when data is retrieved from IS/IT systems. This chapter thus addressed the third and fourth objectives of the study.

Qualitative interviews were first conducted, and the results used to extend the context-based data interface model into a context-based information interface framework. The CBII model was validated using structural equation modelling; the results confirmed a significant relationship between context-based data and quality of information. Thus, the findings from the interviews and the survey informed the development of a context-based information interface framework for knowledge activities. The next chapter reports the third iteration of the HII framework by extending the context-based information interface model in this chapter into a context-based knowledge interface model for knowledge activities.

Chapter 6
Context-Based Knowledge Interface Model and HII Framework

6.1 Introduction

This chapter focuses on the third iteration leading to the development of context-based knowledge interface artefact and the final HII framework. The chapter is organised in three parts. The first part is a qualitative approach to extend the context-based information interface (CBII) model from Chapter 5 into a context-based knowledge interface (CBKI) model. The second part focuses on validating the CBKI model through a quantitative approach by modelling the relationship between context-based information and the quality of knowledge with individual culture and interface factors as mediators. The third part of this chapter is the development of the integrated human information interface framework for information and knowledge activities.

6.2 Context-Based Knowledge Interface Model

Knowledge is actionable information. Quality knowledge could be said to occur when available information allow users to be adaptable, applicable, expandable, true, justified (Wang & Strong 1996) and innovative (Sasidharan et al. 2012) to different situation. The importance of context-based data to ensuring quality information has been demonstrated in Chapter 4. Similarly, context-based information is expected to enhance the quality of knowledge and insights to be gained from IS/IT systems. The availability of information with context details such as “what”, “who”, “when”, “where”, “how”, “why” and “situation” (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) about an object or event would in no doubt increase the programmability of the IS/IT systems to produce more insights and intelligence whilst increasing the range of usability and applicability of the knowledge so generated.

There has been many developments in areas of context-aware systems, especially location-based systems. However, most of these systems have only leverage a limited number of context details as their building blocks. For example, location-based systems mostly focus descriptive and predictive behaviours and phenomenon based on geographical location and time. Expert systems, intelligence agents and artificial intelligence, and IS/IT systems could benefit immensely from the availability of the proposed context-based information. Whilst interfaces of IS/IT systems may be design for interactivity, persuasiveness, friendliness and user experience among others, systems with intelligence and insights offer far more value to users. Therefore, a context-based knowledge interface would enable systems and users to gain truly justified knowledge for adaptability, applicability, expandability and innovativeness (Wang & Strong 1996; Sasidharan et al. 2012).

The next section therefore describes the method used to extend the context-based information interface into a context-based knowledge interface. Intelligent interfaces are used as a proxy to assess the justification for and the prospect of building intelligence into the interface of IS/IT systems.

6.2.1 Method and Procedure

The method and data analysis procedure used in this section were similar to those in Chapter 4 and Chapter 5. Qualitative interviews (Myers & Newman 2007; Yin 2008) generated some insights to extend the context-based information interface framework into a context-based knowledge interface framework. The interviews were conducted face-to-face and in some cases via video calls on skype. The questions were structured around knowledge and intelligent interfaces for IS/IT systems and the prospects of developing such systems. Although, it was meant to be structured interview, where necessary additional questions were asked to gain further insights. The interview sessions were recorded and transcribed and the recordings replayed several times for the purpose of cross-checking and ensuring accuracy. The data analysis procedure followed the thematic analysis process (Braun & Clarke 2006) and accomplished using NVivo 10 software similar to sections. The results of the interviews are presented in the following sections.

6.2.2 Responses from the interviews

Knowledge interfaces are context-aware and intelligent interfaces, which usually have features that allow such systems and users to apply and adapt the information retrieve from IS/IT systems to various situations. Therefore, the design of context-based knowledge interfaces (CBKI) could benefit immensely from the availability of context-based information to allow both systems and users to adapt, apply, expand (Wang & Strong 1996); and innovate (Sasidharan et al. 2012) based on the availability of truly and justified information (Wang & Strong 1996). CBKI would support the codification and use of explicit knowledge as well as the application of tacit knowledge by users to different situations.

The interviewees responded to a question as to whether they think current interfaces of IS/IT systems are intelligent? If not, why and how does this affect the quality of knowledge we capture and store in IS/IT systems.

> *"……but I don't think current interfaces have the kind of intelligence that you are talking about- "context"* (Software Engineer, Consulting Firm, Chile).

> *"No, current interfaces of IS/IT systems are not and cannot be said to be intelligent. Perhaps we should talk about it in terms of computer-based information systems (CBIS)…….they*

currently keep and will ever keep data or information but cannot be intelligent. CBIS only store a bunch of data and information, which serves as the ingredients for sense making…..making new sense requires an intelligent agent, which can be human or artificial intelligent built to replicate human intelligence". (BI Analyst and Solutions Architect, Consulting, UK).

"Not actually….not designed in terms of context but based on frequency and statistical properties which helps to visualise, create relationships and bring some basic intelligence to bear. However, in recent decade interfaces are intelligent using AI, web of knowledge and semantic models". (Research Scientist, NHS, UK).

From the responses, it was clear that current interfaces are not necessarily intelligent to be able to provoke users to provide those details that will make IS/IT systems more intelligent. In order to garner evidence about the need for and the possibility of designing context-based knowledge interfaces, interviewees were asked about the whether it is necessary to capture more context details when information is being stored in IS/IT systems? The responses revealed that most of the interviewees affirmed the significance of context-based information to the design of intelligence interfaces. The general opinions expressed by the interviewees include:

"yes, context-based information are very important for incorporating into intelligence interfaces of IS/IT systems" (IT Manager, Stock Market, Ghana).

"*… From my experience working as AI system developer, yes context details are crucial to develop AI systems".* (Research Scientist, NHS, UK).

"… like I said before key context details are needed for insights, intelligence and knowledge else decisions, actions, knowledge and learning including machine learning can only be based on assumptions" (BI Analytics Consultant, Consulting, UK).

The need to store explicit knowledge including formal norms, rules, policies in a potential intelligent interface for insights were echoed by some of the respondents.

"*…CBIS can only be intelligent if business rules are stored with the data or information to help the system to derive sense".* (BI Analyst and Solutions Architect, Consulting, UK).

" ….the interfaces can be designed to be intelligent based on what you want to do and the system specification. For example, as part of a team we develop a software for a bank, by building a store of state machine based on business rules, regulations and policies, and depending on the client profile details, the state machine can trigger an action for the bank staff and for the superior to approve a service or product for a client", so yes intelligence can be built into the interfaces" (Software Engineer, Consulting Firm, Chile).

The indications from these responses are that context-based information are crucial to the design of context-based knowledge interface for IS/IT systems.

The prospects of building more context into IS/IT systems, were explored. All the interviewees were expressed optimism about the potential of building more context into the interfaces of IS/IT systems. Their responses suggest that this will not only enhance the quality of knowledge derived from stored information in IT systems, but it will also make computers more intelligent. The responses reflect the opportunity to adopt, apply, adapt, leverage, innovate based on explicit and tacit knowledge from context-based information. For example,

> *"…….recent AI interfaces are designed with the know how to store and retrieve focused information or key variables for specific purpose"* (Research Scientist, NHS, UK).

> *"……certainly context-based intelligence systems would have positive impact on machine learning and deep learning, machine-learning"* (BI Analytics Consultant, Consulting, UK).

> *" ….the interfaces can be designed to be intelligent based on what you want to do and the system specification. For example, as part of a team we develop a software for a bank, by building a store of state machine based on business rules, regulations and policies, and depending on the client profile details, the state machine can trigger an action for the bank staff and for the superior to approve a service or product for a client", so yes intelligence can be built into the interfaces, "…….surely more contexts will make systems more intelligent".* (Software Engineer, Consulting Firm, Chile).

> *"…….gather the needed insight and intelligence and develop appropriate data solutions and services for our market"* (Data Scientist, International Company, UK).

> "…*for example in the banking industry, intelligent interfaces would allow organisations to know the trends of customer needs and satisfaction through analytics and can create products according to the wants of customers*" (MIS Analyst, Bank, Ghana).

The responses show that the interviewees had positive outlook about the prospects of building more context into the interfaces of IS/IT systems to make for insight rather than just automation (Davenport et al. 2012). The indications are that from context-based knowledge interfaces, users can gain good knowledge, which they can adopt and adapt to different situations or leverage for enormous benefits. The design of context-aware software (Cases et al. 2013) and by extension context-based knowledge interface for IS/IT systems, AI systems, intelligent agents, expert systems that enables users to engage in well informed knowledge activities are seen as the next generation IS/IT systems (Davenport et al. 2012).

6.3 Development of the CBKI Artefact

The development of the artefact at this stage is based on the assumption that the design of context-based data and information interfaces would have laid the foundation for the knowledge interfaces. That is the context-based data interface would have allowed for the storage of context -based details such as “why’, “how”, “where”, “when”, “who” and “situation” in addition to the “what” about an object in the environment, and the subsequent retrieval of context-based data through a proposed context-based information interface and used for knowledge activities. Subsequently, interviews were used to ascertain how a context-based information interface (CBKI) could be extended into a context-based knowledge interface for knowledge activities. The responses of the interviews showed that in addition to the ability to retrieve those context-details about and object/event, a knowledge interface should allow for users to be able to apply the and adapt (Wang and Strong 1996) these to make better decisions, gain insights, intelligence and solve problems. This is show as the pragmatic layer of the iterative framework circled in Fig. 6.1.

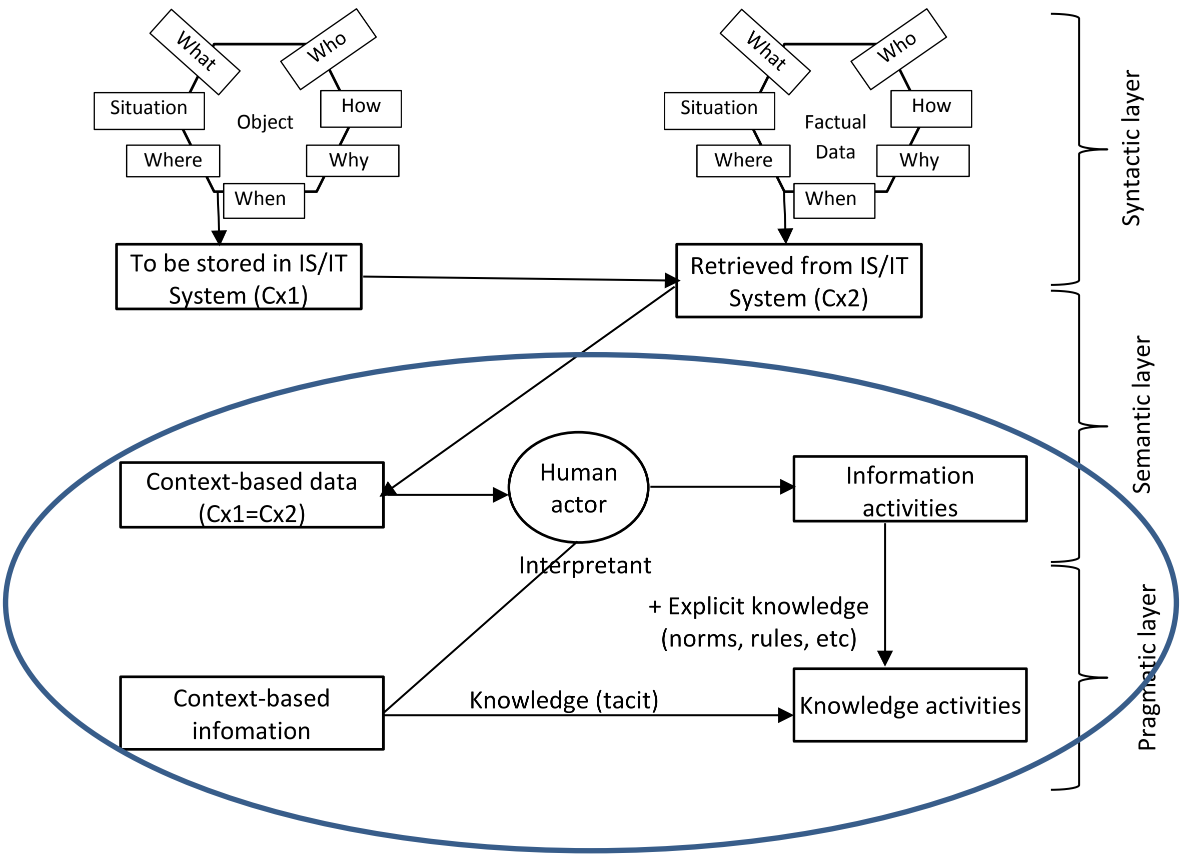


Figure 6.1: Mini artefact 3 - Context-based knowledge interface framework

The context-based information interface was therefore extended into a CBKI by showing how the outcome of the information activities results in stored knowledge in IS/IT systems (i.e. context-informed explicit knowledge) which could be leveraged by users to engage in context-specific knowledge activities. Features of the CBKI, which could potentially include state machine, reference engine, knowledge agent etc., would enable users who retrieve the context-informed explicit knowledge and apply their tacit knowledge to it to engage in quality knowledge activities.

The next section provides proof of the significance of CBKI for knowledge activities by validating the relationship between CBKI and quality of knowledge. The results showed significantly positive relationship between CBKI and quality of knowledge. In addition, individual culture was found to have a significant mediation effect on the relationship between CBKI and quality of knowledge.

6.4 Validating the Context-based Knowledge Interface Framework

In this section, an assumption is made that knowledge, which is actionable information, is derived from information; hence, context-based information is used as a proxy for information object. An assessment of the nature and significance of the relationship between context-based information, a human actor, interface factors and quality of knowledge is carried out through structural equation modelling. Context-based information was derived from literature (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) and human actor or human factors was represented by individual culture (Yoo et al. 2011; Hofstede et al. 2001). Iinterface factors were represented by the semantic and social environment components (Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006) and quality of knowledge (Wang & Strong 1996; Sasidharan et al. 2012) is used as a proxy for information object (Fig. 6.2).

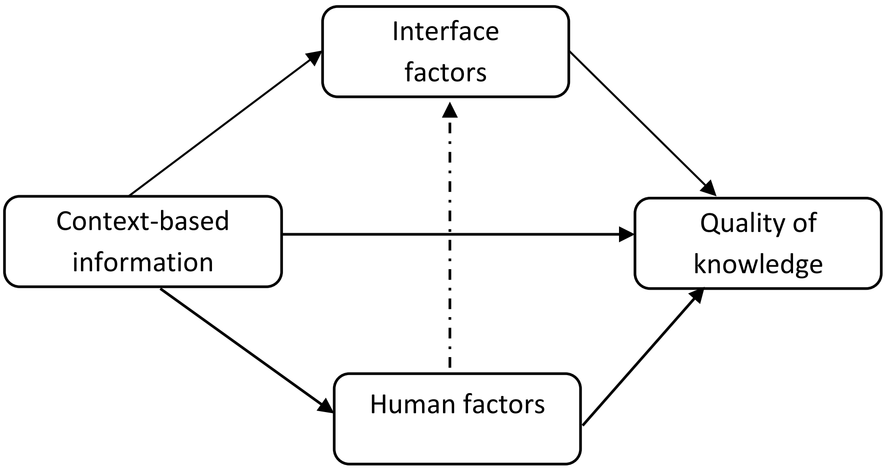


Figure 6.2: General model of the context-based information and quality of knowledge

The aim of this modelling was to provide proof of the interrelationships between the constructs and to justify the potential of developing context-based knowledge interfaces for IS/IT systems. The model assumes a relationship between context-based information and the quality of knowledge stored in or derived from stored information in IS/IT systems. Furthermore, human factors and interface factors were assumed to impact on the quality of knowledge whilst also mediating the relationship between context-based information and the quality of knowledge.

6.4.1 Research Methods and Procedure

The research methods and procedure used in this section were similar to those in Chapter 4 section 4.4.1. The questionnaire had four sub-sections namely context-based information, interface factors, individual cultural and quality of knowledge. There was also a section on demographic characteristics of the respondents. The key constructs, items and sources of the questions are shown in Table 6.1.

Table 6.1: Constructs used in the SEM questionnaire

Constructs	Items	Source
Context-based information (CBI)	Who, why, where, when, how and what	Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007)
	Situation	Sowa (2004)
Interface factors	Context, impacts, intention, acquisition, usability	Marchionini (2008); Barron et al. (1999); Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Quality of Knowledge	Adaptable, applicable, expandable, true, justified	Wang & Strong (1996)
	Innovativeness	Sasidharan et al., (2012)
Individual culture	Collectivism, uncertainty avoidance, long-term orientation	Yoo et al. (2011)

All the items for the constructs were developed from critical review of literature and similar instruments and anchored on a 7-point Likert-scale (Oates 2006; Olivier 2004; Zikmund et al. 2013). The questions were very brief, unambiguous and easy to answer (Rogers et al. 2011; Myers 2009) and the questionnaire was tested for reliability and validity (Straub et al. 2004; Venkatesh & Brown 2013).

6.4.2 Measurement development and data collection

In this round of the analysis, a total of 255 responses from the online survey was used. The questionnaire was made up of four main constructs namely context-based information (CBI), interface factors (IF), human factors (HF) and quality of knowledge (QOK). CBI was measured with 7 items namely "what", "who", "when", "where", "how", "why" and "situation" (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003). Quality of knowledge was measured with six items namely adaptability, applicability, expandability, true, innovative and justified (Wang & Strong 1996; Sasidharan et al. 2012). Human factors was measured by a 26-item five-dimensional scale of individual cultural values, the CVSCALE (Yoo et al. 2011) whilst interface factors was measured by three semantic components namely acquisition, intention and usability; and two social environment components namely interaction context and interaction impact (Fig. 6.3). All the five sub-components of interface factors were measured with 3-items each. The measurement items for all the construct were anchored on a 7-point Likert scale. The questionnaire also had a section for demographic information of the respondents.

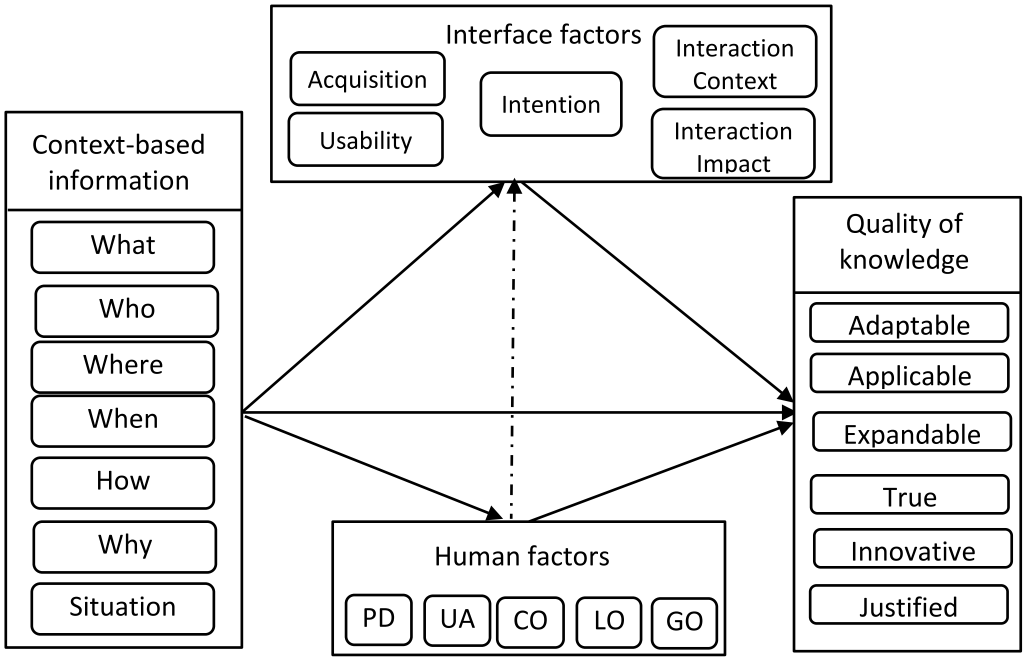


Figure 6.3: Detailed model of the relationship between CBI and QoK

The questionnaire was mounted on Qualtrics online platform and data collected by the time of the analysis were used for the modelling.

6.4.3 Data Analysis and Results

The data analysis methods and procedure were similar to those in Chapter 4 section 4.4.1. The respondents were made up of 51.6% males and 48.4% females. The majority (54.6%) of the respondents were between ages 20-29 years with at least undergraduate level certification (64.3%). The proportion of students among the respondents was 53.7% with the remaining 46.3% holding positions in industry.

6.4.4 Assessment of the measurement model

Exploratory factor analysis (EFA) was used to assess the measurement model. The purpose of this model was to ascertain if context-based information would have any significant relationship with the quality of knowledge derived from information stored in IS/IT systems. The main constructs in the model were context-based information (CBI) and quality of knowledge (QOK) with human factors (HF) and interface factors (IF) as mediators (Fig. 6.4). The significance of the model was first determined, and then quality checks were done on the constructs and items. This was followed with path analysis where path coefficients and R-square values were used to assess the nature, magnitude and significance of the relationship between the constructs at the 0.05 level of significance.

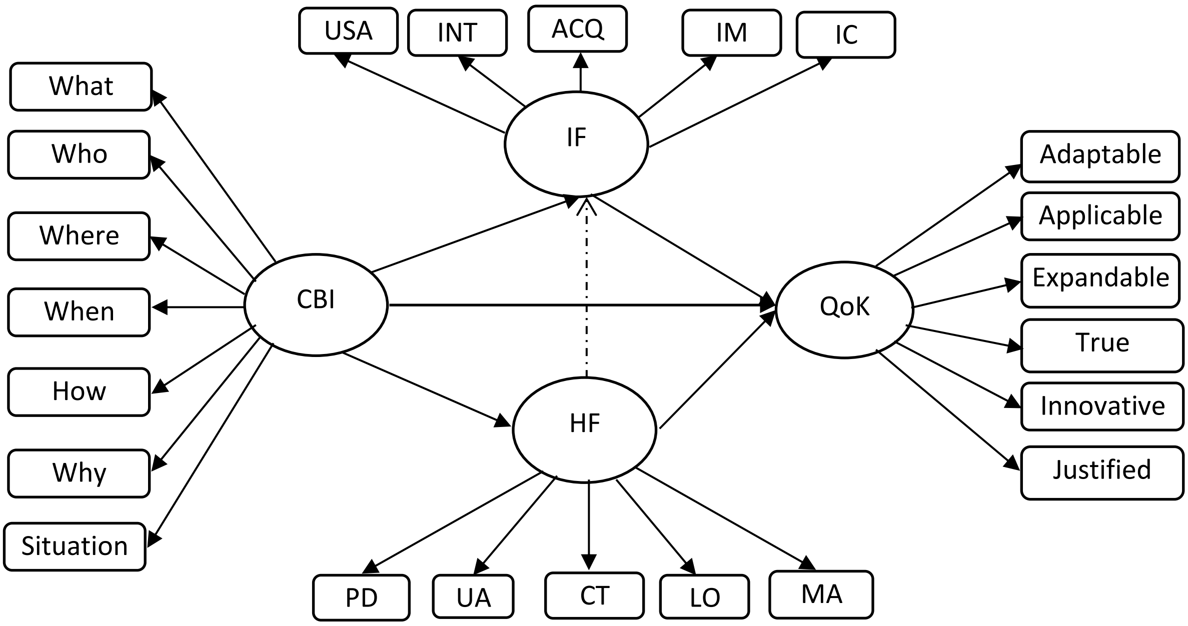


Figure 6.4 : Model of the inter-relationships between the constructs

A test for multicollinearity was carried out on the constructs with second order items to ensure there was no overfitting. The results (Table 6.2) show that the variance inflation factor (VIF) values observed for the models ranged between 1.293 to 3.959, which were all less than the acceptable threshold of 5 (Hair et al. 2017). Similarly, the associated tolerance values observed ranged from 0.250 to 0.650 all of which were above the recommended threshold value i.e. tolerance > 0.1 (Howitt & Cramer 2011). Therefore, multicollinearity was not an issue in this model.

Table 6.2: Multicollinearity diagnostics test for the second-order items

Constructs/ items	VIF	Tolerance
ACQ1	1.616	0.620
ACQ2	2.526	0.400
ACQ3	2.301	0.430
COI1	3.305	0.300
COI2	3.444	0.290
COI4	2.851	0.350
ICX1	2.578	0.390
ICX2	3.048	0.330
ICX3	1.962	0.510
IIM1	2.097	0.480
IIM2	2.723	0.370
IIM3	1.769	0.570
INT1	1.293	0.770
INT2	1.728	0.580
INT3	1.881	0.530
LOI1	2.064	0.480
LOI3	2.692	0.370
LOI4	2.900	0.340
LOI5	2.535	0.390
LOI6	2.833	0.350
UAI1	2.653	0.380
UAI3	3.344	0.300
UAI3	3.685	0.270
UAI5	3.453	0.290
UAI5	3.959	0.250
USA1	1.603	0.620
USA2	1.895	0.530
USA3	1.547	0.650

The measurement model was assessed for reliability and validity of the items for ten distinct latent variables (context-based information, uncertainty avoidance, collectivism, long-term orientation, intention, acquisition, usability, impact and interaction context and quality of knowledge). The standardized factor loadings observed (Table 6.3) were greater than the suggested benchmark of 0.50 (Hair et al. 2010; Ain et al. 2016). This show that all the items loaded very well on the dependent variable.

Table 6.3: Factor loadings of the latent variables for CBI, IF, HF and QOK

Items	ACQ	CBI	CO	HF	IC	IF	IM	INT	LO	QOK	UA	USA
ACQ1	0.803											
ACQ2	0.907											
ACQ3	0.890											
CBI1		0.793										
CBI2		0.884										
CBI3		0.879										
CBI4		0.874										
CBI5		0.896										
CBI6		0.825										
CBI7		0.985										
COI1			0.930									
COI2			0.930									
COI4			0.910									
ICX1					0.898							
ICX2					0.921							
ICX3					0.855							
IIM1							0.852					
IIM2							0.909					
IIM3							0.842					
INT1								0.738				
INT2								0.832				
INT3								0.874				
LOI1									0.819			
LOI3									0.858			
LOI4									0.874			
LOI5									0.839			
LOI6									0.867			
QOK1										0.851		
QOK2										0.842		
QOK3										0.853		
QOK4										0.785		
QOK5										0.822		
QOK6										0.722		
UAI1											0.907	
UAI3											0.926	
UAI5											0.929	
USA1												0.832
USA2												0.871
USA3												0.799

The reliability of the measurement constructs was assessed using the Cronbach alpha and composite reliability methods. The Cronbach alpha values observed (Table 6.4) ranged between 0.747 and

0.950, and were all greater than the recommended mark of 0.70 (Churchill 1979; Ain et al. 2016; Chong et al. 2018). Also, the values of the composite reliability test for the direct relationship between the constructs ranged from 0.856 and 0.959, all of which were greater than recommended threshold of 0.70 (Ain et al. 2016; Chong et al. 2018). Therefore, the measurement constructs were confirmed to be reliable.

Table 6.4: Reliability and validity test results

Constructs	Cronbach's Alpha (>0.70)	rho_A	Composite Reliability (CR) >0.70	Average Variance Extracted (AVE) >0.50
ACQ	0.835	0.845	0.901	0.753
CBI	0.950	0.953	0.959	0.771
CO	0.914	0.916	0.946	0.853
HF	0.922	0.925	0.934	0.562
IC	0.871	0.873	0.921	0.796
IF	0.931	0.933	0.940	0.511
IM	0.836	0.837	0.902	0.754
INT	0.747	0.754	0.856	0.666
LO	0.905	0.905	0.929	0.725
QOK	0.897	0.899	0.921	0.662
UA	0.910	0.910	0.944	0.848
USA	0.782	0.785	0.873	0.697

Convergent (Average Variance Extracted) and discriminant (Fornell-Larcker) validity tests were used to assess the validity of the measurement constructs (Chong et al. 2018). The AVE values observed ranged between 0.88 and 1.77 (Table 6.4) against the recommended threshold of > 0.50 (Fornell & Larcker 1981; Ab Hamid et al. 2017; Chong et al. 2018). The values of the constructs' correlations are below the values of the constructs' square root (Table 6.5).

Table 6.5: Results of Fornell-Larker Criterion for discriminant validity

Constructs	ACQ	CBI	CO	HF	IC	IF	IM	INT	LO	QOK	UA	USA
ACQ	0.868											
CBI	0.259	0.878										
CO	0.155	0.396	0.923									
HF	0.383	0.323	0.320	0.750								
IC	0. 330	0.197	0.118	0.331	0.892							
IF	0.459	0.282	0.194	0.397	0.465	0.715						
IM	0.579	0.263	0.213	0.383	0.606	0.400	0.868					
INT	0.369	0.202	0.096	0.270	0.671	0.464	0.630	0.816				
LO	0.394	0.580	0.476	0. 459	0.401	0.440	0.406	0.352	0.851			
QOK	0.318	0.582	0.391	0.393	0.207	0.297	0.253	0.213	0.660	0.814		
UA	0.356	0.554	0.493	0.457	0.233	0.296	0.294	0.153	0.666	0.335	0.921	
USA	0.574	0.259	0.239	0.278	0.560	0.384	0.530	0.661	0.268	0.247	0.181	0.835

The results (Table 6.6) of the cross loadings of the principal constructs were above the recommended threshold of 0.707 (Ab Hamid et al. 2017; Chong et al. 2018). Therefore, discriminant and convergent validities were confirmed for the measurement model.

Table 6.6: Cross Loadings of the latent variables for CBI, IF, HF and QOK

Items	ACQ	CBI	CO	HF	IC	IF	IM	INT	LO	QOK	UA	USA
ACQ1	0.803	0.205	0.128	0.295	0.523	0.661	0.456	0.502	0.297	0.280	0.275	0.450
ACQ2	0.907	0.213	0.116	0.334	0.649	0.775	0.514	0.621	0.359	0.269	0.303	0.519
ACQ3	0.890	0.254	0.159	0.364	0.715	0.792	0.534	0.610	0.364	0.281	0.346	0.523
CBI1	0.268	0.793	0.299	0.448	0.197	0.276	0.244	0.187	0.408	0.441	0.399	0.256
CBI2	0.263	0.884	0.372	0.585	0.204	0.244	0.227	0.132	0.539	0.504	0.528	0.184
CBI3	0.198	0.879	0.344	0.524	0.146	0.234	0.223	0.157	0.478	0.451	0.472	0.263
CBI4	0.165	0.874	0.317	0.517	0.129	0.211	0.241	0.166	0.496	0.507	0.448	0.187
CBI5	0.216	0.896	0.331	0.570	0.172	0.265	0.235	0.230	0.560	0.540	0.487	0.264
CBI6	0.231	0.825	0.375	0.564	0.185	0.235	0.190	0.179	0.512	0.553	0.509	0.193
CBI7	0.251	0.985	0.385	0.602	0.179	0.270	0.258	0.192	0.552	0.563	0.545	0.251
COI1	0.151	0.377	0.930	0.696	0.107	0.194	0.224	0.116	0.462	0.391	0.502	0.223
COI2	0.142	0.363	0.930	0.658	0.121	0.165	0.149	0.062	0.442	0.358	0.426	0.222
COI4	0.134	0.356	0.910	0.639	0.099	0.178	0.216	0.085	0.412	0.331	0.435	0.217
ICX1	0.728	0.195	0.135	0.319	0.898	0.801	0.563	0.589	0.370	0.195	0.230	0.520
ICX2	0.619	0.132	0.085	0.272	0.921	0.769	0.513	0.601	0.332	0.175	0.199	0.518
ICX3	0.602	0.201	0.096	0.295	0.855	0.744	0.546	0.607	0.372	0.184	0.192	0.459
IIM1	0.522	0.197	0.156	0.275	0.504	0.678	0.852	0.493	0.285	0.205	0.218	0.463
IIM2	0.467	0.258	0.215	0.358	0.468	0.669	0.909	0.531	0.357	0.253	0.296	0.426
IIM3	0.516	0.229	0.183	0.362	0.599	0.731	0.842	0.609	0.411	0.202	0.252	0.487
INT1	0.476	0.235	0.105	0.263	0.478	0.657	0.536	0.738	0.335	0.259	0.151	0.538
INT2	0.558	0.131	0.061	0.156	0.545	0.701	0.508	0.832	0.206	0.091	0.078	0.507
INT3	0.598	0.137	0.071	0.245	0.614	0.753	0.503	0.874	0.323	0.179	0.146	0.574
LOI1	0.327	0.505	0.468	0.784	0.318	0.364	0.339	0.275	0.819	0.584	0.590	0.250
LOI3	0.379	0.563	0.408	0.778	0.321	0.407	0.378	0.349	0.858	0.582	0.563	0.264
LOI4	0.348	0.549	0.381	0.784	0.383	0.385	0.280	0.317	0.874	0.575	0.578	0.262
LOI5	0.283	0.408	0.390	0.735	0.305	0.327	0.326	0.269	0.839	0.482	0.496	0.169
LOI6	0.335	0.438	0.378	0.786	0.380	0.389	0.405	0.287	0.867	0.582	0.603	0.194
QOK1	0.265	0.470	0.307	0.578	0.118	0.203	0.182	0.121	0.541	0.851	0.559	0.157
QOK2	0.204	0.428	0.315	0.540	0.104	0.164	0.100	0.077	0.487	0.842	0.525	0.198
QOK3	0.209	0.533	0.286	0.548	0.188	0.220	0.179	0.172	0.557	0.853	0.469	0.168
QOK4	0.326	0.503	0.325	0.591	0.233	0.330	0.295	0.274	0.593	0.785	0.501	0.249
QOK5	0.324	0.465	0.336	0.599	0.208	0.327	0.265	0.270	0.574	0.822	0.547	0.305
QOK6	0.211	0.433	0.339	0.516	0.151	0.191	0.201	0.107	0.453	0.722	0.492	0.117
UAI1	0.316	0.552	0.475	0.801	0.208	0.274	0.266	0.151	0.632	0.619	0.907	0.192
UAI3	0.327	0.472	0.462	0.782	0.242	0.260	0.248	0.119	0.593	0.549	0.926	0.123
UAI5	0.342	0.506	0.425	0.784	0.193	0.283	0.299	0.153	0.614	0.583	0.929	0.185
USA1	0.530	0.215	0.115	0.178	0.546	0.684	0.426	0.559	0.178	0.190	0.138	0.832
USA2	0.495	0.263	0.204	0.291	0.448	0.666	0.424	0.592	0.308	0.233	0.188	0.871
USA3	0.406	0.167	0.290	0.228	0.402	0.608	0.481	0.501	0.184	0.195	0.126	0.799

A full collinearity test was also carried out on the four main constructs (Table 6.7). The results revealed VIF values within the range 1.190 and 1.790. This means lateral collinearity was not a major concern in this model. Also, the VIF values of all the latent constructs were lower than 3.3 (Chong et al. 2018), therefore common method bias was not a major concern in the model.

Table 6.7: Full collinearity test results

Constructs	VIF Values
Quality knowledge (QoK)	1.190
Context-based information (CBI)	1.638
Human factors (HF)	1.790
Interface factors (IF)	1.634

Generally, the assessments of the measurement model did not reveal any significant concerns about the reliability and validity of the measurement model. Therefore, the measurements are considered fit to be used in modelling the relationship between the identified constructs (QOK, CBI, HF and IF).

6.4.5 Assessment of the structural model (path analysis)

The structural model was assessed to ascertain if the data fit the model, and whether the relationships between the constructs were significant. The results showed that the model was significant in establishing a relationship between the constructs (R^2= 0.517, $p<0.05$). Therefore, there was a good fit between the data and the structural model. The results from the path analysis are shown in Fig. 6.5 and Table 6.8.

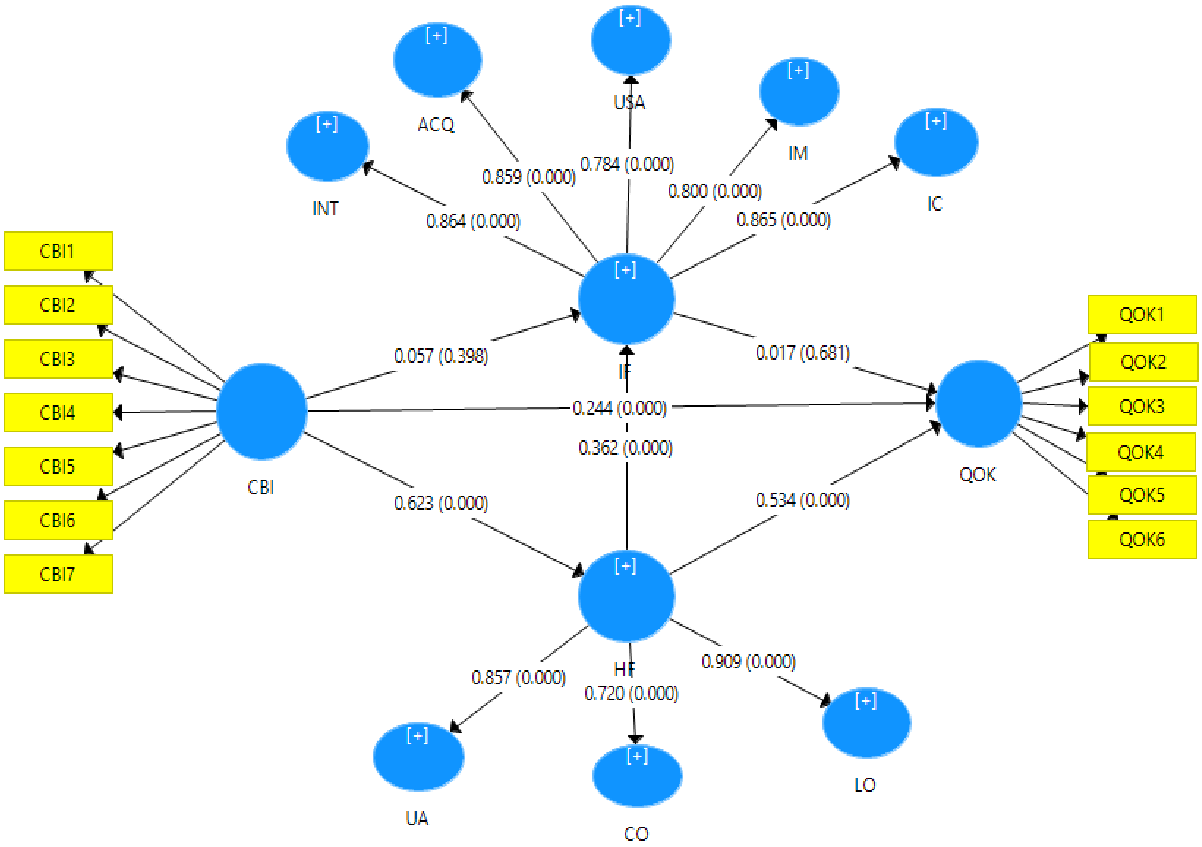


Figure 6.5: Output of the Research Model

The results (Fig. 6.5) revealed a significant relationship between CBI and QoK (β=0.244, p<0.05). However, whilst the relationship between CBI and HF (β=0.623, p<0.05); and HF and QOK (β=0.534, p<0.05) were significant, those between CBI and IF (β=0.057, p>0.05) and IF and QOK (β=0.017, p>0.05) were not. Furthermore, there was a significant mediation effect of IF and HF on the relationship between CBI and IC (β=0.195, p<0.05) and between CBI and IM (β=0.180, p<0.05). These indicates that the availability of context-based information has implications on the social environment in terms of the impact and the context of application of the information stored in IS/IT systems.

Table 6.8: Path coefficients for the relationship between CBI, QOK, HI and IF

Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
CBI -> HF	0.623	0.627	0.052	12.091	0.000
CBI -> IF	0.057	0.054	0.071	0.796	0.426
CBI -> QOK	0.244	0.252	0.066	3.694	0.000
HF -> IF	0.362	0.368	0.094	3.851	0.000
HF -> QOK	0.534	0.523	0.084	6.335	0.000
IF -> IC	0.865	0.864	0.026	33.482	0.000
IF -> IM	0.800	0.801	0.038	20.877	0.000
IF -> QOK	0.017	0.018	0.045	0.368	0.713
CBI -> IF -> IC	0.049	0.046	0.061	0.802	0.423
CBI -> HF -> IF -> IC	0.195	0.201	0.058	3.343	0.001
CBI -> HF -> IF	0.225	0.232	0.068	3.335	0.001
CBI -> IF -> IM	0.045	0.043	0.057	0.799	0.425
CBI -> HF -> IF -> IM	0.180	0.186	0.055	3.298	0.001
CBI -> HF -> QOK	0.333	0.328	0.058	5.742	0.000
CBI -> IF -> QOK	0.001	0.001	0.004	0.225	0.822
CBI -> HF -> IF -> QOK	0.004	0.005	0.012	0.318	0.750

The joint mediation effect of HF and IF ($\beta=0.004$, $p>0.05$) on the relationship between CBI and QOK was not significant neither was the lone effect of HF ($\beta=0.001$, $p>0.05$) on CBI and QOK (Table 6.8). Consequently, given that the lone effect of HF ($\beta=0.333$, $p<0.05$) on CBI and QOK was significant indicates full mediation with HF accounting for 98.8% of the mediation effect on the relationship between CBI and QOK. This demonstrates that knowledge activities are largely a function of the human user rather than IS/IT system. Therefore, whilst it is important to build more context into the interfaces of IS/IT systems, the quality of knowledge activities that can be generated from the stored information depends on the human user.

6.4.6 Discussion

The purpose of the structural modelling was to validate the relationship between CBI and quality of knowledge in order to demonstrate the potential impact of CBI on the quality of knowledge. The results showed significantly positive relationship between CBI and quality of knowledge. This indicates that context has significant implication for the quality of data, information and knowledge stored in IS/IT systems (Brazier et al. 2000). There is therefore evidence to suggest that context, quantity and quality of data and information have impacts on the quality of knowledge (Anderson et al. 2000; Eppler 2006; Clark 2010) found in IS/IT systems. The significant relationship observed with the relationship between CBI and quality of knowledge ties in with exiting literature (Poston & Speier 2005; Kyoon Yoo et al. 2011).

In addition, individual culture was found to have a significant mediation effect on the relationship between CBI (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) and quality of knowledge (Wang & Strong 1996; Sasidharan et al. 2012). In the hierarchy of data, information and knowledge, computational methods play a critical role in the initial processing of data into information, but they are less effective in transforming information to knowledge (Kanehisa et al. 2014). This means that in addition to the context-based information retrieved from IS/IT systems, it is important that knowledge interfaces allow users to apply and adapt (Wang & Strong 1996) their own knowledge (tacit) to the information in order to enhance the quality of knowledge derived from the IS/IT system. This emphasises the importance of human users or agent in the data, information and knowledge and system interactions (Brazier et al. 2000).

6.4.7 Evaluation

The purpose of the structural modelling in this section was to validate the relationship between context-specific information and the quality of knowledge. The aim was to complete the third iteration of the data, information and knowledge layers leading to the development of the HII framework. The human actor/user retrieves context specific information from IS/IT systems through semiotic processes and uses it to generate knowledge and engage in knowledge activities. However, the mini-artefact 3 (Fig. 6.10) showing the pragmatic layer activities is an extension of artefact 2 (Chapter 5) and does not represent the whole spectrum of the HII framework. Therefore, the mini artefact 3 needs to be finalised to show the entire HII framework from the object or event in the environment, through the storage activities via signs in the IS/IT systems and retrieval of the context-based information to generate knowledge and engage in knowledge activities.

6.4.8 Conclusion

In this section, the proposed context-based knowledge interface framework has been validated using structural equation modelling. The hypothesis that there will be a significantly positive relationship between context-based knowledge interface (CBKI) and quality of knowledge was confirmed. In addition, the results confirmed a significant mediation effect of individual culture (human factor) on the relationship between CBKI and quality of knowledge. Therefore, the mini artefact on how the design of CBKI and could impact on the quality of knowledge has been validated. The indications are that there are indeed huge prospects for the design of context-based interfaces for IS/IT systems although it is conceded that this could be very challenging.

6.5 Finalising the HII Framework

In this section, full consideration is given to all the mini artefacts in order to arrive at an integrated HII framework, which is the main artefact for this study. The HII framework which, reflects an object in the environment, the human actor, interface factors and context-based interfaces for knowledge activities have been iteratively developed and assessed through structural equation modelling (SEM) and interviews. The logical flow of context details is as follows:

> ***Object/event*** ➡ ***factual data*** ➡ ***context-based data*** ➡ ***context-based information-*** ➡ ***Context-based knowledge***

At the syntactic level, an object or event (referent) in the external environment is perceived by a human actor (interpretant) who captures and represents the object/event as a "sign" in an IS/IT system. However, due to individual differences of the human actor and limitations of current interfaces and databases that support the IS/IT systems, only limited details about the object/event (i.e. mostly the "what") are ever captured into the IS/IT system. This result in context deficiencies, which affect the quality of data stored, the information retrieved, and the knowledge generated. Thus, through reductionist principle (Gibson 1978), only limited details are perceived and captured into IS/IT systems. The context-based data interface framework therefore proposes the design of IS/IT system interfaces to capture all the context details about the object/event so that what is retrieved (factual data) is the exact replica of what exist in the external environment (object/event).

At the semantic level of the HII framework, the design of a similar interface called context-based information interface (CBII) is proposed. The CBII would enable users to retrieve context-based data when they interact with the IS/IT systems without the need to rely on their own imagination to understand the original context of object/event. Thus, the availability of context-based data would enable users to understand and make meaning of data retrieved from IS/IT systems. This would improve the quality of information and information activities based on data retrieved from IS/IT systems The outcome at the semantic or meaning making level is the availability of context-based information (CBI), which has implications for quality of knowledge generated.

The pragmatic level framework called context-based knowledge interface (CBKI), is similar to the one at the sematic level. The outcome at the semantic level, which is the CBI, already has the necessary context details to enable users to create knowledge. Users can therefore leverage the stored CBI (explicit knowledge – formal rules, norms, etc.) and apply their own knowledge (i.e. tacit knowledge, informal rules, norms, etc.) to engage in knowledge activities. Thus, users can apply and adapt the CBI to different situations by generating context-based knowledge. The entire HII framework (Fig. 6.6) proposes building context into the data, information and knowledge interfaces of IS/IT systems to improve the quality of data, information, and knowledge when engaging in knowledge activities on IS/IT platform.

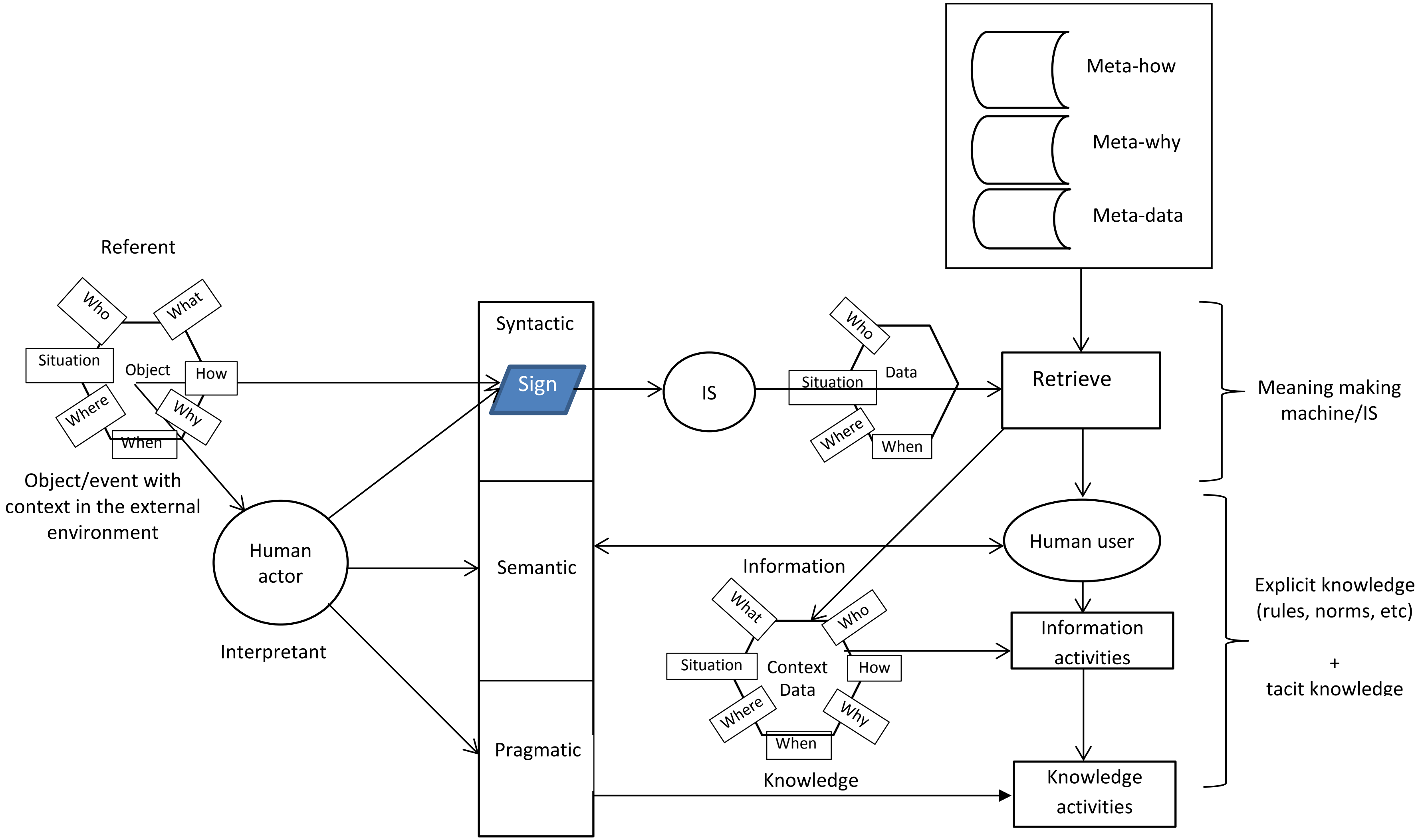


Figure 6.6: Context-based HII Framework for Information and Knowledge Activities

The HII framework (Fig. 6.6) reflects an object in the environment, the human actor, interface factors and context-based interfaces for data, information and knowledge activities. This has been iteratively developed and assessed using structural equation modelling (SEM) and interviews. The data level is synonymous with the syntactic layer of the semiotic framework, information with the semantic layer whilst the pragmatic layer represents the knowledge level. The external environment where the object/event occurs, and the impact of the application knowledge activities can be evaluated is the social environment layer (Liu 2000).

The evidence from the structural modelling and responses from the interviews have demonstrated the significant implications of context-based data and context-based information for quality of data, information, knowledge and knowledge activities. The results also demonstrated the significant mediating roles of the human user (human factors) and interface factors. Another interesting result that emerged was that, the availability of context in the environment does not necessarily translate into quality data in IS/IT systems unless acted upon by human user with his/her semiotic capabilities. In addition, sense making, or understanding and usability of stored data and information retrieved from IS/IT systems are primarily a human function.

Based on the semiotic framework, data activities largely take place at the syntactic level, information activities at the semantic and knowledge at the pragmatic level. Three mini artefacts namely context-based data interface framework, context-based information interface framework and context-based knowledge interface framework were iteratively developed first. The mini artefacts are then integrated into the context-based HII for information and knowledge activities (Fig. 6.6).

The HII framework was inspired by systems theory of human behaviour and semiotics with a focus on the syntactic, semantic and pragmatics layers. A high-level summary of the framework is shown in Fig. 6.7.

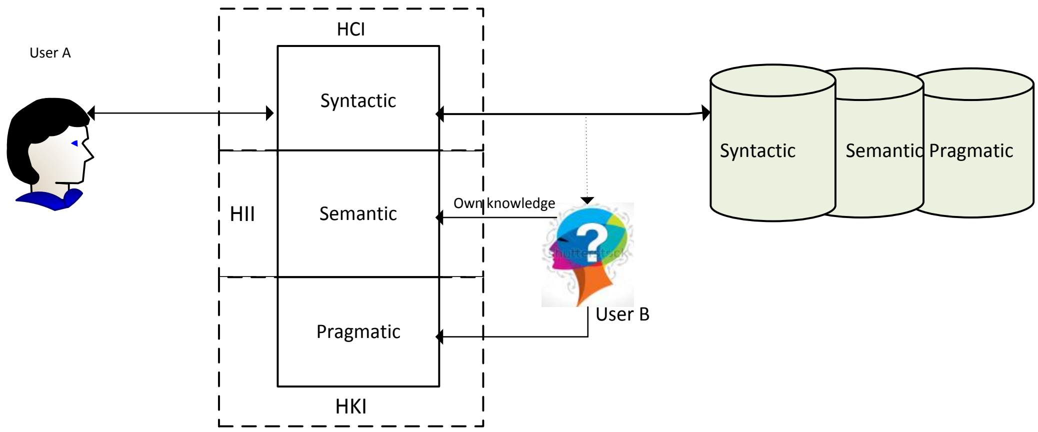


Figure 6.7: The human information and knowledge interface (HII & HKI)

The concepts of HII and HKI are conceived as interdisciplinary fields of study that focuses on the human information and knowledge dynamics. The HII concept is refined whilst the HKI is defined as follows:

- *HII is defined as the point where a human user makes exact meaning of stored data and information devoid of the user's own knowledge and understanding to engage in context specific information activities.*
- *HKI is the interface where a human user is able to adopt and adapt information from IS/IT systems to new situations based on the context of the stored data and information to engage in knowledge activities.*

The syntactic layer is thus conceived as HCI where the focus of the interaction is between the human user (interpretant) and the IS/IT systems with data (signs) being captured through various interfaces. The semantic layer is conceived as the human information interface where the efforts are made to make meaning of the stored data in the IS/IT systems. The pragmatic layer is conceived as the knowledge domain where users leverage on their experiences (tacit knowledge) to create and use knowledge from data and information stored in IS/IT systems to engage in knowledge activities.

It must be noted that our conceptualised of HKI is more inclined to explicit knowledge based on stored data or information in IS/IT systems and less inclined to tacit knowledge. Explicit knowledge represents coded knowledge which can be found in IS/IT systems; whilst tacit knowledge is inseparable from humans. Humans depend on tacit knowledge, to exploit explicit knowledge.

6.6 Chapter Summary

In this Chapter, the third iteration was carried out in order to develop a mini artefact in the form of context-based knowledge interface (CBKI). First, from interviews responses and evidence from literature, the CBKI artefact was developed by extending the context-based information interface (in section) to show how users can adapt and apply the available context-based information to different situations. The responses from the interviews showed that in addition to the ability to retrieve those context-details about an object/event, a knowledge interface should allow users to apply and adapt these to make better decisions, gain insights, intelligence and solve problems. Although not shown in the framework, it is expected that features of the knowledge interface could potentially include state machines, reference engines, and knowledge agents among others, which would enable users who retrieve the context-informed explicit knowledge and apply their tacit knowledge to it to gain quality knowledge.

Secondly, the proposed CBKI framework was then validated quantitatively with survey data. Using structural equation modelling, the hypothesis that there will be a significantly positive relationship between context-based information and the quality of knowledge was confirmed. In addition, individual culture was found to have a significant mediation effect on the relationship between CBKI and quality of knowledge. The artefact was then evaluated, and finalised leading to the proposed HII framework. The concept of human information interface (HII) which to date has not been explicitly defined in IS interactions literature, has been presented. The concept of human knowledge interface (HKI) which hitherto has not been defined in extant literature was introduced and defined. The next chapter presents an evaluation of the entire HII framework using both interviews and structural modelling to ascertain if the framework enhances the quality of knowledge activities.

Chapter 7
Evaluation of the HII Framework

7.1 Introduction

Two of the objectives of this study were to validate the HII framework to assess how it enhances the usability of information from computer-based systems; and to evaluate the framework to ascertain the extent to which improved data, information and knowledge interface design impact on knowledge activities. In this chapter the HII framework is evaluated (Hevner 2007; Vaishnavi and Kuechler 2004; Vaishnavi 2008) for validity, utility and acceptability (Hevner et al. 2004). The validity of the framework is assessed through a hypothetical experiment from quantitative survey where the relationship between the proposed context-based interfaces (i.e. interfaces that incorporate context details such as the "what", "where", "why", "how", "when", "who", and "situation") and knowledge activities is investigated using SmartPLS (Ringle et al. 2015) for structural equation modelling (SEM). The main hypothesis is that "there will be a significantly positive relationship between context-based interfaces and the quality of knowledge activities". These were tested for data, information and knowledge interfaces to validate the data, information and knowledge parts of the HII framework and how each impact on knowledge activities.

Again, the validity; together with the utility and applicability of the framework was assessed through expert interviewers who also provided illustrative case studies to demonstrate the utility of the framework. These evaluation processes were not only meant to meet the philosophical underpinnings of ontology, epistemology and axiology of the study, but also to demonstrate the rigour associated with the use of design science research paradigm. The results from the evaluations of the HII framework provided very useful feedback especially from the expert reviewers, which serves as a basis for optimising the initial HII framework.

7.2 Evaluating the Validity of the HII Framework

The validity of the HII framework is carried through a structural equation modelling assessing the relationship between context-based data interface, context-based information interface, and context-based knowledge interface and knowledge activities. Context-based data (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) is used as a proxy for data interface and context-based information (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) for information interface and context-based knowledge (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) for knowledge interface. The semiotic inspired interface factors (Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink &

Wijnhoven 2006) and individual culture or human factors (Yoo et al. 2011) serves as a mediators for the impact of context-based data and information interface on knowledge activities.

Knowledge activities (Matusik & Heeley 2005; Lai & Lee 2007; Beesley and Cooper 2008; Sowe et al 2008; Lew & Yuen 2014; Lew et al. 2013) based on stored information in IS/IT systems depends on the quality of data and information stored and retrieved from the system. However, the quality of data, information and knowledge stored and retrieved from IS/IT systems do not depend only on the availability of the context (Kyoon Yoo et al. 2011) details on the data within the environment, but also on the user and the capabilities of the IS/IT system interfaces to adequately capture and store the context details. In effect, context has a significant impact on knowledge activities (Kanehisa et al. 2014; Kyoon Yoo et al. 2011). It is therefore assumed that context-based data, information and knowledge interfaces would impact on the quality of knowledge activities (Baskerville and Dulipovici 2006) based on stored data, information and knowledge in IS/IT systems.

Knowledge is dependent on context (Kyoon Yoo et al. 2011) and different context factors such as culture (Baskerville & Dulipovici 2006; Kyoon Yoo et al. 2011), time, goals, space, environment (Dzandu et al. 2014) affect knowledge activities. An adequate consideration of context is therefore required to ensure the effective use of the knowledge (Poston & Speier 2005; Kyoon Yoo et al. 2011). The aim of all the validation processes it to ascertain whether quality of IS (denoted by context-based data, information and knowledge interfaces) affect the quality of KACT. These constructs have been used in establishing the initial framework, quality of knowledge activities is used as a proxy for knowledge activities (Fig. 7.1).

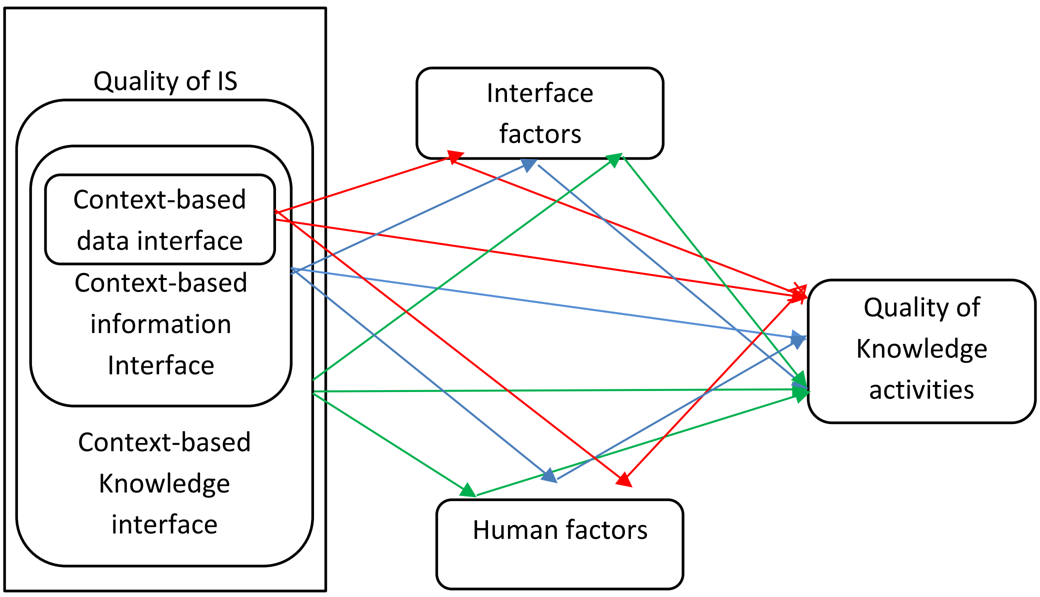


Fig. 7.1: Model of Context-based IS Interface and Knowledge Activities

For simplicity and to specifically address whether context-based data interface (CBDI), context-based information interface (CBII) and context-based knowledge interface (CBKI) have impact on the quality of knowledge activities separately, the model (Fig. 7.1) is decomposed into three, one each for CBDI, CBII and CBKI in an iterative process where CBDI serves as input for CBII, and CBII as input for CBKI. The structural equation modelling process, which follows next in the sections first looks at CBDI and knowledge activities (KACT); followed by CBII and KACT and CBKI and KACT.

7.3 Evaluating the relationship between CBDI and KACT

The first iteration of the quantitative evaluation of the HII framework is the validation of the relationship between a hypothetical context-based data interface and the quality of knowledge activities. The survey assumes that when IS/IT systems interfaces are designed to capture the proposed context details namely “what”, “where”, “why”, “how”, “when”, “who”, and “situation” (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007; Sowa 2003) about an object or event from the environment it will ensure the availability of quality data in the form of context-based data. Users can therefore access and retrieve context-based data from IS/IT systems for knowledge activities. This section therefore tests the hypothesis that *“quality IS in the form of context-based data interface will have a significantly positive relationship with the quality of knowledge activities”* (Fig. 7.2).

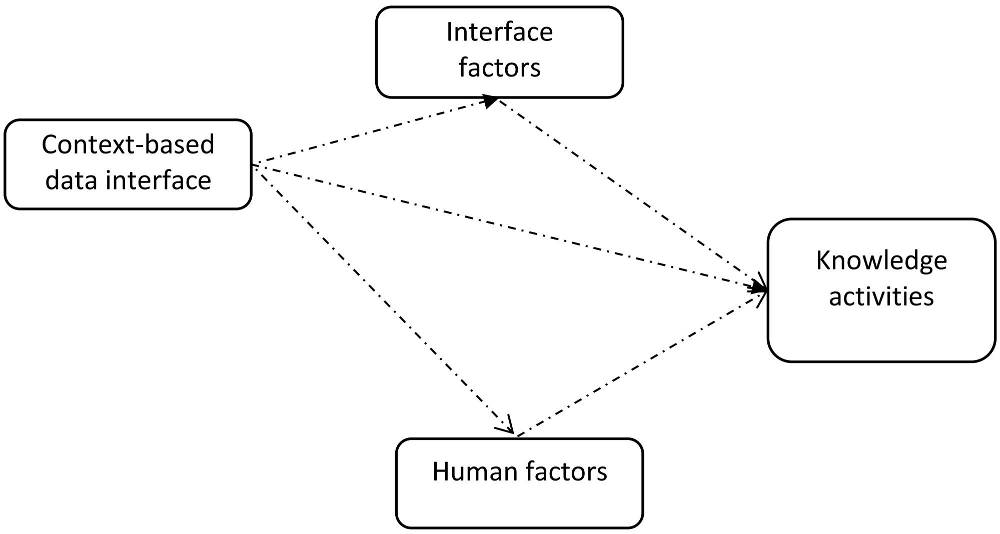


Fig. 7.2: Model of the Context-based data interface for knowledge activities

The method and procedure used to collect the quantitative data, the data analysis procedure, results, discussion, evaluation and conclusion are discussed next.

7.3.1 Research Method and Procedure

In this quantitative study, questionnaires are used to collect cross-sectional data from respondents who meet the set criteria. The questions were designed to illicit the respondent's expectations of context-based IS interfaces and their perceptions of the potential impact of the context-based interfaces on the quality of knowledge activities. The questionnaire had four sub-sections namely individual culture or human factors, interface factors (IF), context-based data interface (CBDI) and knowledge activities. The key constructs, items and sources of the questions are listed in Table 7.1.

Table 7.1: Constructs used in the SEM questionnaire

Constructs	Items	Source
Context-based data interface (CBDI)	Who, why, where, when, how and what	Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007)
	Situation	Sowa (2004)
Interface factors	Intention, acquisition, usability	Marchionini (2008); Barron et al. (1999), Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Knowledge activities (KACTs)	Acquisition, capturing, storing, reusing, externalising, stimulating, identifying new knowledge, and leveraging of knowledge	Matusik & Heeley (2005); Lai & Lee (2007); Beesley & Cooper (2008); Sowe et al (2008); Lew & Yuen (2014); Lew et al. (2013)
Individual culture (IC)	Power distance, collectivism, uncertainty avoidance, long-term orientation, masculinity	Yoo et al. (2011)

The questions were first tested for reliability and validity as suggested by Straub et al. (2004) and Venkatesh & Brown (2013) in a pilot study. The items were measured on a 7-point Likert-scale (Oates 2006; Olivier 2004; Zikmund et al. 2013). Generally, all the questions in the questionnaire were very brief, unambiguous and easy to answer (Rogers et al. 2011; Myers 2009).

7.3.2 Measurement development and data collection method

In this survey, a total of 254 usable responses from an online survey was used for the structural modelling. The questionnaire was made up of six main constructs namely context-based data interface (CBDI), context-based information interface (CBII), context-based knowledge interface (CBKI), interface factors (IF), human factors (HF) and knowledge activities (KACT). CBDI and CBII were each measured with 7 items namely "what", "who", "when", "where", "how", "why" (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007); and "situation" (Sowa 2003) about data, information and knowledge. KACT was measured with eight items namely knowledge acquisition, capturing, sharing, storage, reusing, externalising, identifying new knowledge, and leveraging knowledge for new opportunities (Lai & Lee 2007; Beesley & Cooper 2008; Sowe et al. 2008; Lew & Yuen 2014; Lew et al. 2013).

Pragmatic components were used as a proxy for interface factors (Marchionini 2008; Barron et al. 1999; Stamper 1996; Ong & Lai 2007; Kraaijenbrink & Wijnhoven 2006) and was measured by a total of 9-items, 3 each for intention, acquisition and usability. The human factor was measured by a 26-item five-dimensional scale of individual cultural values, the CVSCALE (Yoo et al. 2011) adopted and adapted to information activities in IS/IT systems. All the items were measured on a 7-point Likert scale. A detailed model of the relationship between CBDI and KACT is shown in Fig. 7.3

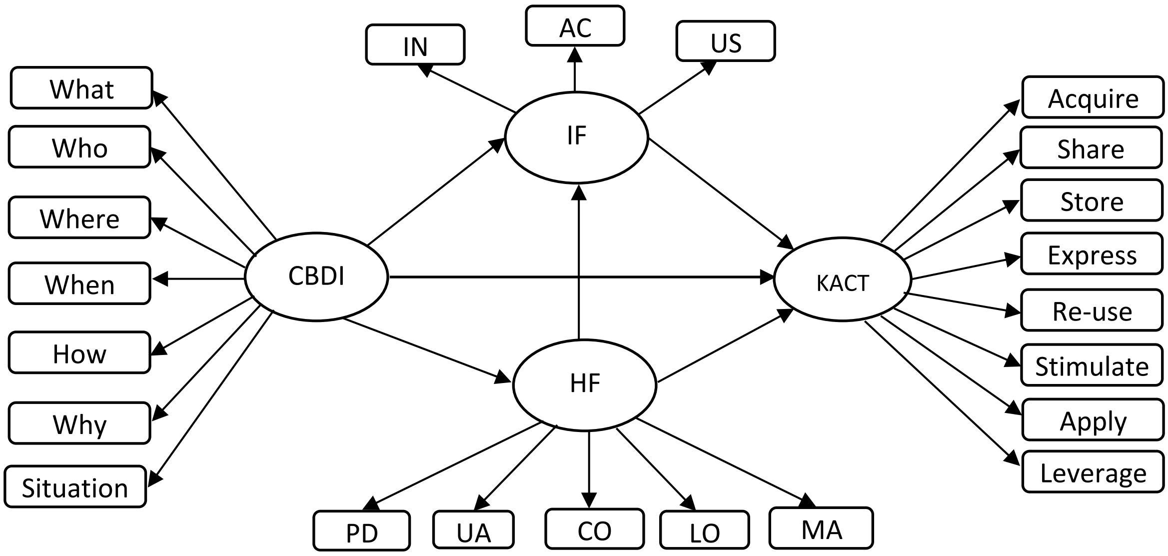


Figure 7.3: Detailed model of CBDI and knowledge activities

The questionnaire (Appendix IV) which had a total of 23 items was administered online using Qualitrics.com and face-to-face. The survey link was emailed to currents and former students in University of Reading, UK and the University of Ghana, members of the British Computer Society Berkshire Branch committee members and email contacts in my address back. In addition, various social media channels such as Facebook, LinkedIn and WhatsApp platforms were used to promote the survey link. The online survey was supplemented by face-to-face data collection where the researcher printed and administered hard copies of the questionnaire to potential respondents during research seminars, workshops and other gatherings. The completed questionnaire collected by face-to-face were coded and captured in MS Excel 2016 and saved as comma separated vale (CVS) file that was later merged with the pre-coded data responses obtained from the online survey mounted on Qualtrics.

7.3.3 Data Analysis and Results

The entire dataset was cleaned to ensure reliability, consistency and validity of the responses. Depending how each respondent completed the questionnaire, some partial responses were used whilst other were discarded. Although the data was screened, all the respondents met the minimum requirements of 18years + and have ever used IS/IT systems or devices for data, information and knowledge activities. Therefore, no respondent was disqualified based on the set criteria. The data (i.e. the pre-processed file in CSV) was then imported into SmartPLS for the structural equation modelling. The measurements and constructs were defined, models were created and the PLS algorithm was run to assess the model measurements and conduct the relevant path analysis.

7.3.4 Assessment of the measurement model

The measurement model fit was assessed using exploratory factor analysis (EFA). The purpose was to ascertain the significance of the relationship between context-based data interface (CBDI) and context-based information, (CBII) and knowledge activities (KACT) quality (IQ) with human factors (HF) and interface factors (IF) as moderators. The path coefficients and r-square values were used to determine the nature, magnitude and significance of the relationship between the constructs at the 0.05 level of significance. Table 7.2 shows the collinearity diagnostics test for the items.

Table 7.2: Multicollinearity diagnostics test for the second-order items

Constructs/Items	VIF
UAI1	2.653
UAI3	3.344
UAI5	3.453
COI1	3.490
COI2	2.983
COI6	2.225
LOI1	2.306
LOI2	1.862
LOI3	2.756
LOI4	2.916
LOI5	2.643
LOI6	2.851
INT1	1.293
INT2	1.728
INT3	1.881
ACQ1	1.617
ACQ2	2.526
ACQ3	2.301
USA1	1.603
USA2	2.093
USA3	1.547

Multicollinearity diagnostics (Table 7.1) was carried out on the constructs with second order items for HF and IF in an effort to avoid overfitting. The test results showed that the variance inflation factor (VIF) values observed for the models ranged between 1.293 and 3.490 which were less than the acceptable threshold of VIF <5 (Hair et al, 2017). Therefore, multicollinearity was not an issue in this model.

The reliability and validity of the second-order items for an initial eight constructs were assessed. These were power distance, uncertainty avoidance, collectivism, long-term orientation, masculinity for human factors (individual culture), and intention, acquisition and usability for interface factors (pragmatic components). Through iterative runs of the PLS algorithm, the outer loadings and AVE threshold were not met until all the items for power distance and masculinity, two items for uncertainty avoidance and three items for collectivism were completely dropped.

Cronbach alpha and composite reliability methods were used to assess the reliability of the measurement constructs. The Cronbach alpha values recorded ranged between 0.747 to 0.944 (Table 7.3. Thus all the Cronbach alpha values were greater than the recommended mark of 0.70 (Churchill 1979; Ain et al. 2016; Chong et al. 2018). Also, the values of the composite reliability for the direct relationship between the constructs ranged from 0.856-0.967, which were all greater than the recommended 0.70 (Ain et al. 2016; Chong et al. 2018). Therefore, the measurement constructs were reliable.

Table 7.3: Reliability and validity test results

Constructs	Cronbach's Alpha (>0.70)	rho_A	Composite Reliability(CR) >0.70	Average Variance Extracted (AVE) >0.50
ACQ	0.835	0.843	0.901	0.754
CBDI	0.935	0.938	0.948	0.722
COI	0.893	0.895	0.933	0.824
HF	0.926	0.928	0.936	0.552
IF	0.889	0.893	0.911	0.533
INT	0.747	0.756	0.856	0.666
KACT	0.944	0.945	0.953	0.719
LOI	0.908	0.910	0.929	0.687
UAI	0.910	0.910	0.944	0.848
USA	0.782	0.787	0.873	0.697

The validity of the measurement constructs was assessed using the convergent (Average Variance Extracted) and discriminant (Fornell-Larcker) validity tests (Chong et al. 2018). The observed AVE values were in the range of 0.552 and 0.848 (Table 7.2). Thus the AVE values were greater than the recommended threshold of > 0.50 (Fornell & Larcker 1981; Ab Hamid et al. 2017; Chong et al. 2018). In addition, most of the cross loadings (Table 7.4) of the principal constructs were above the recommended threshold of 0.707 (Chong et al. 2018). Although some values were lower, these still had the highest values with the construct to which they have been assigned (Hair et al. 2017).

Table 7.4: Cross loadings for the relationship between CBDI, HF, IF and KACT

Cross Loadings	ACQ	CBDI	COI	HF	IF	INT	KACT	LOI	UAI	USA
ACQ1	0.806	0.210	0.131	0.298	0.683	0.502	0.269	0.304	0.275	0.449
ACQ2	0.907	0.241	0.131	0.341	0.794	0.621	0.309	0.363	0.303	0.519
ACQ3	0.887	0.244	0.170	0.363	0.784	0.610	0.392	0.359	0.346	0.523
CBD1	0.221	0.806	0.348	0.504	0.259	0.221	0.439	0.488	0.402	0.234
CBD2	0.281	0.816	0.373	0.556	0.322	0.266	0.475	0.537	0.454	0.292
CBD3	0.172	0.855	0.349	0.538	0.176	0.133	0.382	0.514	0.461	0.149
CBD4	0.251	0.853	0.325	0.538	0.281	0.237	0.444	0.515	0.479	0.244
CBD5	0.196	0.861	0.439	0.598	0.253	0.243	0.490	0.569	0.471	0.220
CBD6	0.241	0.759	0.418	0.555	0.261	0.209	0.402	0.505	0.466	0.228
CBD7	0.224	0.981	0.435	0.626	0.274	0.238	0.497	0.592	0.520	0.254
COI1	0.150	0.409	0.934	0.692	0.187	0.115	0.473	0.473	0.503	0.222
COI2	0.142	0.420	0.910	0.655	0.163	0.061	0.463	0.463	0.427	0.221
COI6	0.160	0.409	0.878	0.644	0.187	0.108	0.504	0.457	0.428	0.220
INT1	0.476	0.243	0.122	0.277	0.668	0.735	0.318	0.342	0.151	0.537
INT2	0.557	0.178	0.066	0.160	0.723	0.832	0.237	0.205	0.078	0.507
INT3	0.597	0.225	0.073	0.244	0.781	0.875	0.317	0.311	0.146	0.575
KACT1	0.292	0.398	0.445	0.552	0.326	0.263	0.805	0.516	0.416	0.293
KACT2	0.357	0.458	0.440	0.588	0.371	0.317	0.834	0.557	0.459	0.286
KACT3	0.298	0.433	0.453	0.593	0.320	0.287	0.807	0.586	0.413	0.246
KACT4	0.308	0.422	0.441	0.580	0.352	0.315	0.867	0.562	0.426	0.290
KACT5	0.320	0.482	0.482	0.646	0.354	0.316	0.869	0.625	0.485	0.284
KACT6	0.336	0.504	0.470	0.641	0.348	0.332	0.902	0.613	0.499	0.235
KACT7	0.322	0.439	0.424	0.591	0.325	0.308	0.867	0.557	0.484	0.213
KACT8	0.306	0.443	0.424	0.558	0.298	0.266	0.826	0.520	0.445	0.199
LOI1	0.327	0.531	0.478	0.793	0.329	0.275	0.551	0.825	0.590	0.251
LOI2	0.280	0.473	0.468	0.701	0.268	0.226	0.500	0.753	0.442	0.186
LOI3	0.385	0.546	0.430	0.790	0.392	0.355	0.626	0.853	0.569	0.276
LOI4	0.348	0.552	0.403	0.790	0.358	0.317	0.579	0.863	0.578	0.264
LOI5	0.283	0.484	0.382	0.737	0.279	0.269	0.525	0.830	0.496	0.170
LOI6	0.334	0.530	0.386	0.781	0.317	0.287	0.548	0.843	0.603	0.195
UAI1	0.316	0.521	0.482	0.783	0.257	0.151	0.479	0.626	0.907	0.193
UAI3	0.326	0.487	0.460	0.764	0.224	0.119	0.499	0.593	0.926	0.124
UAI5	0.342	0.506	0.437	0.768	0.266	0.153	0.502	0.609	0.929	0.185
USA1	0.529	0.175	0.123	0.180	0.728	0.559	0.193	0.178	0.138	0.829
USA2	0.495	0.310	0.205	0.293	0.747	0.592	0.291	0.309	0.188	0.876
USA3	0.406	0.198	0.294	0.229	0.647	0.500	0.275	0.187	0.127	0.796

In effect, all the items loaded very well as the standardised factor loadings were greater than the suggested threshold of 0.50 (Hair et al. 2010; Ain et al. 2016). Therefore, discriminant and convergent validities were confirmed for the measurement model.

The values of the construct's correlations are below the values of the constructs' square root (Table 7.5).

Table 7.5: Results of Fornell-Larker Criterion for discriminant validity

Constructs	ACQ	CBDI	COI	HF	IF	INT	KACT	LOI	UAI	USA
ACQ	0.868									
CBDI	0.268	0.850								
COI	0.166	0.454	0.908							
HF	0.386	0.361	0.331	0.743						
IF	0.470	0.309	0.197	0.366	0.730					
INT	0.368	0.263	0.105	0.277	0.489	0.816				
KACT	0.375	0.529	0.528	0.302	0.398	0.356	0.848			
LOI	0.395	0.328	0.511	0.424	0.393	0.349	0.370	0.829		
UAI	0.356	0.548	0.500	0.438	0.271	0.153	0.536	0.362	0.921	
USA	0.574	0.275	0.244	0.281	0.449	0.361	0.302	0.271	0.182	0.835

The full collinearity test results showed VIF values ranging between 1.744 and 1.870 (Table 7.6). Thus, lateral collinearity was not a major concern of this study. Also, the computed VIF values for all the latent constructs were lower than 3.3 (Chong et al. 2018), therefore the model does not suffer significantly from common method bias.

Table 7.6: Full collinearity test results

Constructs	VIF Values
Context-based data (CBDI)	1.791
Human factors (HF)	1.744
Interface factors (IF)	1.165
Knowledge activities (KACT)	1.870

In all, the assessments of the measurement model did not reveal any significant concerns with respect to the reliability and validity of the measurement model. Therefore, the measurements were considered fit to be used in modelling the relationship between CBDI, and KACT with IF and HF as mediators.

7.3.5 Assessment of the structural model (path analysis)

The structural model was assessed to establish whether the data fit the model and the significance of the relationships between the constructs. The results showed that the model was significant in explaining the variance of the dependent variable, KACT (R^2=0.521, $p<0.05$). Therefore, there was a good fit between the data and the structural model. The significance of the relationships between the constructs were then assessed through path analysis (Fig. 7.4 and Table 7.7).

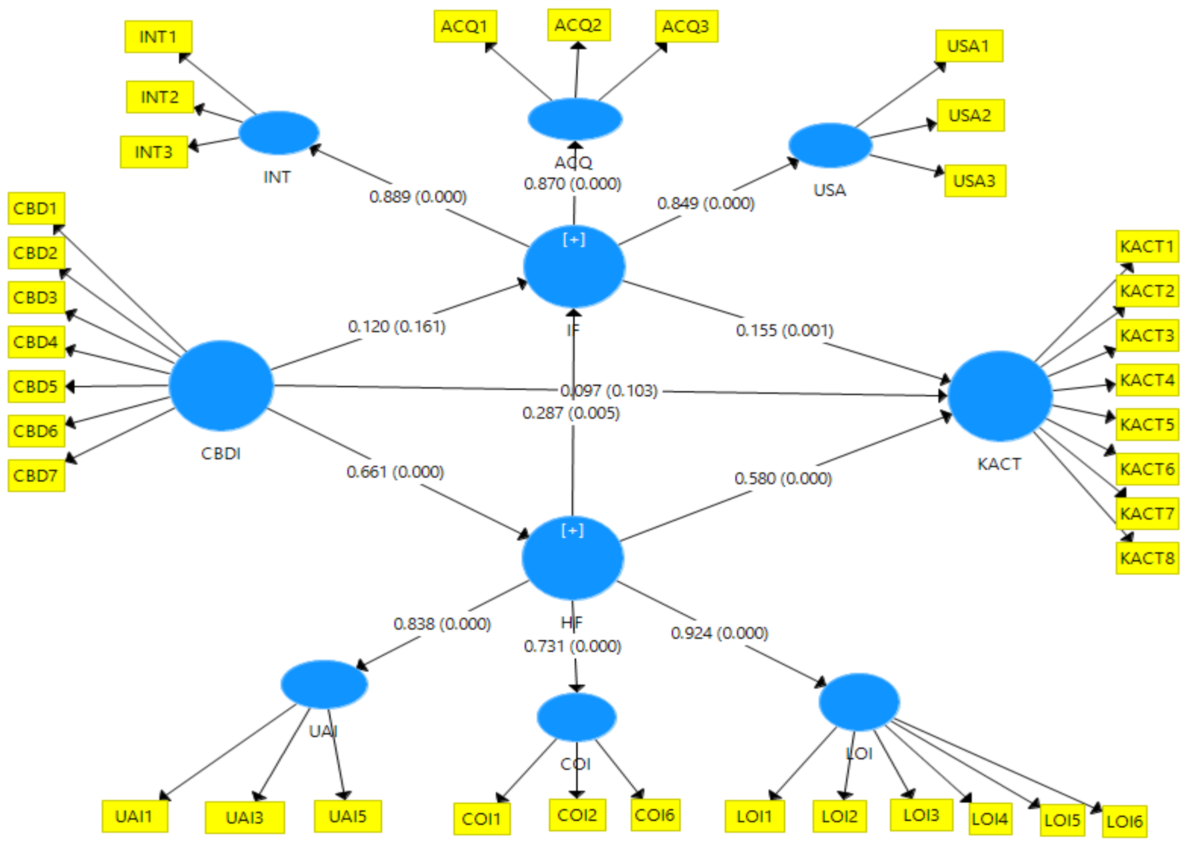


Figure 7.4: Output of the Research Model for CBDI and KACT

The results (Fig. 7.7) of the path analysis showed no significant relationship between CBDI and KACT (β=0.097, p>0.05). However, although both IF (β=0.155, p<0.05) and HF (β=0.580, p<0.05) exhibited significant relationship with KACT, their joint mediation effect on KACT was not significant (β=0.029, p>0.05) as shown in Table 7.7.

Table 7.7: Path coefficients for direct and indirect effects for CBDI, HF, IF and QKACT

Paths	Original Sample (O)	Sample Mean (M)	Stand. Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
CBDI -> HF	0.661	0.663	0.055	11.952	0.000
CBDI -> IF	0.120	0.114	0.085	1.403	0.161
CBDI -> KACT	0.097	0.098	0.060	1.630	0.103
HF -> IF	0.287	0.293	0.102	2.816	0.005
HF -> KACT	0.580	0.578	0.066	8.809	0.000
IF -> KACT	0.155	0.160	0.048	3.246	0.001
CBDI -> HF -> IF	0.189	0.196	0.076	2.484	0.013
CBDI -> HF -> KACT	0.383	0.383	0.051	7.546	0.000
CBDI -> IF -> KACT	0.019	0.018	0.015	1.215	0.224
CBDI -> HF -> IF -> KACT	0.029	0.033	0.019	1.584	0.113

The mediation effect of IF on the relationship between CBDI and KACT ($\beta=0.019$, $p=0.224$) was not significant but the mediation effect of HF on the relationship between CBDI and KACT was significant ($\beta=0.383$, $p=0.000$) and the direct effect of HF on IF was significant ($B=0.247$, $p<0.05$). This indicates that the mediation effect is highly dependent on HF other than IF. There is thus full mediation effect of HF on the relationship between CBDI and KACT (i.e. about 95.04%).

Quality of knowledge activities is therefore largely a function of the human user and not an information system. This confirms the concept of the disappearing computer and the focus on human interface with information. IS/IT system is only a tool for information activities, whilst understanding and usability of information is largely human-centred.

7.3.6 Discussion of the results on the relationship between CBDI and KACT

This first iteration validated the HII framework at the data layer using survey data and structural modelling. The result showed a significantly positive relationship between context-based data interfaces and knowledge activities (Baskerville & Dulipovici 2006). Not only did this confirm the impact of the design of quality IS in the form of CBDI, but also reiterates the assertion that knowledge activities is dependent on context (Kanehisa et al. 2014; Kyoon Yoo et al. 2011). There is thus a potential that CBDI would help capture and store more details of an event or object in an IS/IT system which would enhance the quality of data retrieved to generate quality information for quality knowledge activities. In addition, the results have implication for the design of context-aware software (Cases et al. 2013) and "insightful IS systems" (Davenport et al. 2012) which would in no doubt enhance the quality of user interaction, usability of information and the quality of knowledge activities.

According to Brazier et al. (2000) best alternative to enhance the diagnostic abilities of reasoning process of IS/IT systems is to explore the option to collect additional information about the situation. The design of quality IS in the form of context-based data interface is seen as a feasible solution to the current challenge of inadequate context in stored data. It is expected CBDI would increase the availability of data (quantity) as well as the nature and variety of data (Anderson et al. 2000) which has implications for the quality of information and knowledge activities. Therefore, adequate consideration of context is necessary when data is retrieved from IS/IT systems to ensure effective use for knowledge activities (Poston & Speier 2005; Kyoon Yoo et al. 2011). Although the design of context-based data interface is expected to demand more effort from users during data storage into IS/IT systems, there would be a need to complete these efforts with automatic systems configurations which can capture some of the context details defined in the HII framework. There will also be the need to strike a balance between interactivity, user friendly, persuasiveness and the burden of effort to be placed on users by the design of CBDI for IS/IT systems.

7.3.7 Evaluation of the relationship between CBDI and KACT

The results of the structural model on the relationship between CBDI and KACT has indeed established that the design of context-based data interface has implications for the quality of knowledge activities. Given that the HII framework is new, there is the need to demonstrate the validity of the HII framework at each layer of the DIK pyramid. It would be wrong to assume that CBDI would literally guarantee same impact on the quality of knowledge activities as CBII. It is however safe to assume that the availability of CBDI provides opportunity to store context-based data in IS/IT systems. The same system analysis and design requirements used in designing the CBDI can be used to design CBII to ensure that when users interact with IS/IT systems they can retrieve context-based data to generate information for knowledge activities. It is therefore necessary to validate the HII framework at the information level by modelling the relationship between CBII and KACT whilst considering the mediating effect of individual culture and interface factors.

7.3.8 Conclusion on the of the relationship between CBDI and KACT

In this section, structural modelling has been used to prove that the design of quality IS that incorporates context-based data interfaces would have a significant positive impact on the quality of knowledge activities. The results also showed that individual culture (human factors) had the most significant mediation effect on the relationship between CBDI and KACT accounting for 95% of the mediation effect. This in effect indicated that the interface factors of intention, acquisition and usability of data although had direct impact on the quality of KACT, were perhaps inseparable from the human factors. Thus, semiotic capabilities are indirectly embedded within the capabilities of the individual or the human when he/she interfaces with data to engage in knowledge activities. However, before data is used for knowledge activities, it has to be transformed into information. The results of the structural model of the CBDI and KACT therefore informs the evaluation of the relationship between CBII and KACT in the next section.

7.4 Evaluation of the relationship between CBII and KACT

The output from the previous section on CBDI is used as input for the second iteration to validate the relationship between context-based information interface (CBII) and knowledge activities (KACT). The underlying assumption for this validation is that the design of context-based information interface would depend on the pre-design of context-based based data interface to capture data into the IS/IT system. Subsequently, users can retrieve the context-based data through a similar interface (i.e. the proposed CBII) in order to have access to context-based information for knowledge activities. It is therefore hypothesised that *"the design of CBII would have a significantly positive relationship with the quality of knowledge activities".*

Based on the proposed HII framework, the role of the human actor is very critical to the entire human interface with data, information and knowledge. From existing literature (e.g. Hwang and Lee 2012; Brazier et al. 2000), the role of mediators and moderators in knowledge activities especially the role of humans are emphasised. Therefore, the role of the human actor as the retrieval agent of the context-based data stored in the IS/IT systems is considered for mediation effects. Similarly, a selection of interface factors relevant to knowledge activities namely intention, acquisition and usability, based on the model of the human-information interface model were considered and tested for significant mediation effects. The next section provides details on the methods used, analysis, discussion, evaluation and conclusion of the results on the relationship between CBII and KACT.

7.4.1 Research Method and Procedure

This section describes the research method and procedure used to carry out the second iteration to validate the relationship between context-based information interface and knowledge activities. The approach is similar what was used in the first iteration and follows the design science research process of methods, design, discussion, evaluation and conclusion. The methods begin with the measurement development and data collection procedure.

7.4.2 Measurement development and data collection – CBII and KACT

The questionnaire had five sub-sections namely interface factors, individual cultural or human factors, and a section on context-based information interface. The remaining sub-section was on knowledge activities. There was also a section on demographic characteristics of the respondents. The CBII construct was measured with seven items; interface factors with nine items whilst knowledge activities had eight items. Individual culture construct was measured with sixteen items. In all, each item was anchored on a 7-point Likert-scale (Oates 2006; Olivier 2004; Zikmund et al. 2013) and the questions were clearly outlined to make it very easy for respondents to answer (Rogers et al. 2011; Myers 2009). The key constructs, items and sources of the questions are shown in Table 7.8.

Table 7.8: Constructs used in the SEM questionnaire

Constructs	Items	Source
Context-based information interface (CBII)	Who, why, where, when, how and what	Jang & Woo (2003); Abowd & Mynatt (2000); Truillet (2007)
	Situation	Sowa (2004)
Interface factors	Intention, acquisition, usability	Marchionini (2008); Barron et al. (1999); Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Knowledge activities (KACTs)	Acquisition, capturing, storing, reusing, externalising, stimulating, identifying new knowledge, and leveraging of knowledge	Matusik & Heeley (2005); Lai & Lee (2007); Beesley & Cooper (2008); Sowe et al (2008); Lew & Yuen (2014); Lew et al (2013)
Individual culture (IC)	Collectivism, uncertainty avoidance, long-term orientation	Yoo et al. (2011)

The questionnaire was designed and mounted online using Qualtrics software. Group as well as personal emails were sent to potential respondents from my address book to respectfully request their assistance in completing the survey via a web link. In addition, invitations were sent to potential respondents via other social media and online platforms such as WhatsApp, LinkedIn, Facebook and member list of IT professions in the UK. Although the link to the survey was left open for longer period, data collected as at the end of the 3rd month were used for the analysis. The pre-coded data was downloaded in a CSV file format and cleaned by removing incomplete and no response data. In all a total of 256 cases was imported into the SmartPLS software for analysis.

7.4.3 Data Analysis and Results – CBII and KACT

The analysis of data and presentation of the results follows the two-step format of assessment of the measurement model and assessment of the structural model (path analysis).

7.4.4 Assessment of the measurement model – CBII and KACT

The SEM steps used in Chapter 4 section 4.4.1 were repeated to evaluate the impact of CBII on KACT with HI and IF as mediators. The results (Table 7.9) of the multicollinearity diagnostics test for the second-order items yielded VIF's less than 5 (Hair et al. 2017).

Table 7.9: Multicollinearity diagnostics test for the second-order items

Items	VIF
ACQ1	1.617
ACQ2	2.526
ACQ3	2.301
COI1	3.582
COI2	3.438
COI4	3.840
COI6	3.002
INT1	1.293
INT2	1.728
INT3	1.881
LOI1	2.306
LOI2	1.862
LOI3	2.756
LOI4	2.916
LOI5	2.643
LOI6	2.851
UAI1	3.045
UAI3	3.727
UAI5	3.989
USA1	1.603
USA2	1.894
USA3	1.547

Furthermore, all the items loaded very well as shown in the cross loadings in Table 7.10.

Table 7.10: Cross loadings for the relationship between CBII, HF, IF and KACT

Items	ACQ	CBII	COI	HF	IF	INT	KACT	LOI	UAI	USA
ACQ1	0.806	0.205	0.127	0.289	0.683	0.502	0.269	0.304	0.275	0.449
ACQ2	0.907	0.214	0.127	0.329	0.794	0.621	0.309	0.363	0.303	0.519
ACQ3	0.887	0.256	0.168	0.354	0.784	0.610	0.392	0.358	0.346	0.523
CBI1	0.267	0.797	0.327	0.457	0.274	0.186	0.443	0.416	0.401	0.256
CBI2	0.262	0.884	0.387	0.582	0.224	0.131	0.423	0.539	0.529	0.183
CBI3	0.197	0.879	0.365	0.532	0.236	0.156	0.381	0.492	0.473	0.262
CBI4	0.163	0.872	0.330	0.513	0.198	0.165	0.430	0.492	0.449	0.187
CBI5	0.216	0.894	0.341	0.565	0.272	0.230	0.428	0.561	0.488	0.265
CBI6	0.231	0.822	0.400	0.572	0.233	0.179	0.427	0.522	0.510	0.193
CBI7	0.250	0.985	0.407	0.604	0.267	0.191	0.479	0.557	0.547	0.251
COI1	0.150	0.374	0.914	0.722	0.187	0.115	0.473	0.473	0.503	0.222
COI2	0.142	0.361	0.899	0.688	0.163	0.061	0.463	0.463	0.427	0.221
COI4	0.134	0.354	0.919	0.684	0.167	0.085	0.495	0.437	0.436	0.216
COI6	0.160	0.420	0.882	0.681	0.187	0.108	0.504	0.457	0.428	0.220
INT1	0.476	0.234	0.115	0.267	0.668	0.735	0.318	0.342	0.151	0.537
INT2	0.557	0.131	0.069	0.157	0.722	0.832	0.237	0.205	0.078	0.507
INT3	0.597	0.138	0.071	0.234	0.781	0.875	0.316	0.311	0.146	0.575
KACT1	0.292	0.399	0.453	0.558	0.326	0.263	0.806	0.516	0.416	0.293
KACT2	0.357	0.390	0.442	0.589	0.371	0.317	0.834	0.557	0.459	0.286
KACT3	0.298	0.440	0.450	0.593	0.320	0.287	0.807	0.586	0.413	0.246
KACT4	0.308	0.423	0.438	0.580	0.352	0.315	0.867	0.562	0.426	0.290
KACT5	0.320	0.420	0.486	0.648	0.354	0.316	0.868	0.625	0.485	0.284
KACT6	0.336	0.479	0.477	0.643	0.348	0.332	0.902	0.613	0.499	0.235
KACT7	0.322	0.366	0.438	0.595	0.325	0.308	0.867	0.557	0.484	0.213
KACT8	0.306	0.405	0.442	0.565	0.298	0.266	0.826	0.520	0.445	0.199
LOI1	0.327	0.507	0.468	0.780	0.329	0.275	0.550	0.826	0.590	0.251
LOI2	0.280	0.431	0.471	0.697	0.268	0.226	0.500	0.755	0.442	0.186
LOI3	0.385	0.566	0.423	0.774	0.392	0.355	0.626	0.853	0.569	0.276
LOI4	0.348	0.549	0.393	0.771	0.358	0.317	0.578	0.863	0.578	0.264
LOI5	0.283	0.406	0.387	0.723	0.279	0.269	0.524	0.830	0.496	0.170
LOI6	0.334	0.438	0.381	0.761	0.317	0.287	0.548	0.842	0.603	0.195
UAI1	0.316	0.552	0.473	0.772	0.257	0.151	0.479	0.625	0.907	0.193
UAI3	0.326	0.473	0.465	0.758	0.224	0.119	0.499	0.593	0.926	0.124
UAI5	0.342	0.507	0.434	0.757	0.266	0.153	0.502	0.609	0.929	0.185
USA1	0.529	0.216	0.125	0.181	0.729	0.559	0.193	0.178	0.138	0.830
USA2	0.495	0.263	0.205	0.293	0.747	0.592	0.291	0.309	0.188	0.876
USA3	0.406	0.165	0.289	0.239	0.647	0.500	0.275	0.187	0.126	0.796

Also, all the Cronbach alpha and the composite reliability values were greater than the recommended mark of 0.70 (Churchill 1979; Ain et al. 2016; Chong et al. 2018) as shown in Table 7.11. Therefore, multicollinearity was not a major issue in this model and the measurement constructs were reliable.

Table 7.11: Reliability and validity test results

Construct	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
ACQ	0.835	0.843	0.901	0.754
CBII	0.949	0.952	0.959	0.770
COI	0.925	0.926	0.947	0.816
HF	0.930	0.931	0.939	0.543
IF	0.889	0.893	0.911	0.533
INT	0.747	0.756	0.856	0.666
KACT	0.944	0.945	0.953	0.719
LOI	0.908	0.910	0.929	0.687
UAI	0.910	0.910	0.944	0.848
USA	0.782	0.787	0.873	0.697

The observed AVE values (Table 7.11) were greater than the recommended threshold of 0.50 (Fornell & Larcker 1981; Ab Hamid et al. 2017; Chong et al. 2018). Therefore, discriminant (Table 7.12) and convergent validities were confirmed for the measurement model.

Table 7.12: Results of Fornell-Larcker Criterion for discriminant validity

Construct	ACQ	CBII	COI	HF	IF	INT	KACT	LOI	UAI	USA
ACQ	0.868									
CBII	0.259	0.878								
COI	0.162	0.417	0.903							
HF	0.374	0.325	0.368	0.737						
IF	0.470	0.278	0.195	0.359	0.730					
INT	0.668	0.202	0.102	0.267	0.889	0.816				
KACT	0.375	0.491	0.535	0.705	0.398	0.355	0.848			
LOI	0.395	0.585	0.507	0.907	0.392	0.349	0.670	0.829		
UAI	0.356	0.555	0.497	0.828	0.271	0.153	0.536	0.662	0.921	
USA	0.574	0.260	0.243	0.284	0.850	0.661	0.302	0.271	0.182	0.835

The full collinearity test results showed for the latent constructs revealed VIF values < 5; and also less than 3.3 (Chong et al. 2018) as shown in Table 7.13. Therefore, lateral collinearity was not an issue in this model; and the model does not suffer significantly from common method bias.

Table 7.13: Full multicollinearity test results

Constructs	VIF
CBII	1.650
HF	1.747
IF	1.641
KACT	1.154

The assessments of the measurement model did not reveal any significant concerns in relation to multicollinearity, reliability, validity of the measurement model and common method bias.

Therefore, the measurements can confidently be used to model the relationship between CBII and KACT with IF and HF as mediators.

7.4.5 Assessment of the structural model (path analysis) – CBII and KACT

The outcome of the path analysis first revealed a very good fit between the data and the structural model. The model was significant in explaining 52.4% (R^2=0.524) of the variance of the dependent variable (KACT). The significance of the relationships between the constructs were then assessed through path coefficients (Fig. 7.5 and Table 7.14).

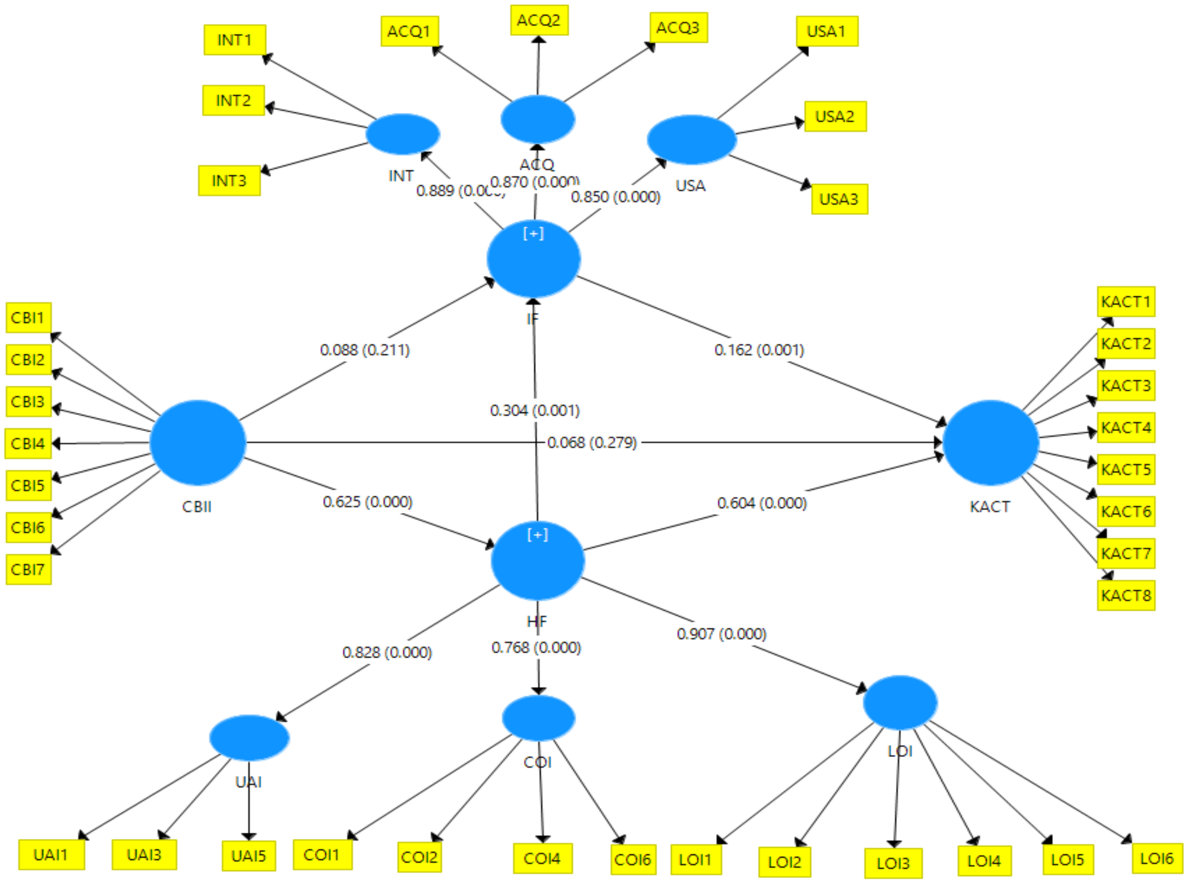


Figure 7.5: Output of the Research Model for CBII and KACT

The results (Fig. 7.5) of the path analysis showed no significant relationship between CBII and KACT (β=0.068, $p>0.05$) and the relationship between CBII and IF was also not significant (β=0.088, $p>0.05$). However, both IF (β=0.162, $p<0.05$) and HF (β=0.604, $p<0.05$) exhibited significant relationship with KACT.

Furthermore, the joint mediation effect of IF and HF on the relationship between CBII and KACT was not significant (β=0.031, $p<0.05$). However, given that the mediation effect of IF (β=0.014, $p>0.05$) on CBII and KACT was not significant, but HF (β=0.304, $p<0.05$) was significantly related to IF, and IF (β=0.162, $p<0.05$) was significantly related to KACT, the indications are that the mediation effect was largely due to HF (β=0.604, $p<0.05$) as shown in Table 7.14. Thus, HF accounted for 96.3% of the mediation effect of CBII on KACT.

Table 7.14: Path coefficients for direct and indirect effects for CBII, IF, HF and KACT

Paths	Original Sample (O)	Sample Mean (M)	Stand. Dev (STDEV)	T Statistics (|O/STDEV|)	P Values
CBII -> HF	0.625	0.628	0.052	12.012	0.000
CBII -> IF	0.088	0.085	0.070	1.250	0.211
CBII -> KACT	0.068	0.069	0.063	1.082	0.279
HF -> IF	0.304	0.308	0.093	3.282	0.001
HF -> KACT	0.604	0.602	0.061	9.970	0.000
IF -> KACT	0.162	0.166	0.047	3.466	0.001
CBII -> HF -> IF	0.190	0.195	0.066	2.883	0.004
CBII -> HF -> KACT	0.378	0.377	0.049	7.768	0.000
CBII -> IF -> KACT	0.014	0.014	0.013	1.103	0.270
CBII -> HF -> IF -> KACT	0.031	0.033	0.017	1.822	0.069

These results re-emphasis the significance of human user in achieving optimum understanding and usability of information retrieved from IS/IT systems for knowledge. The results also underscore the importance of human interface with information and the almost negligible role of IS/IT in the face of the disappearing computer. Fig. 7.6 shows iterations A (context-based data interface) and B (context-based information interface).

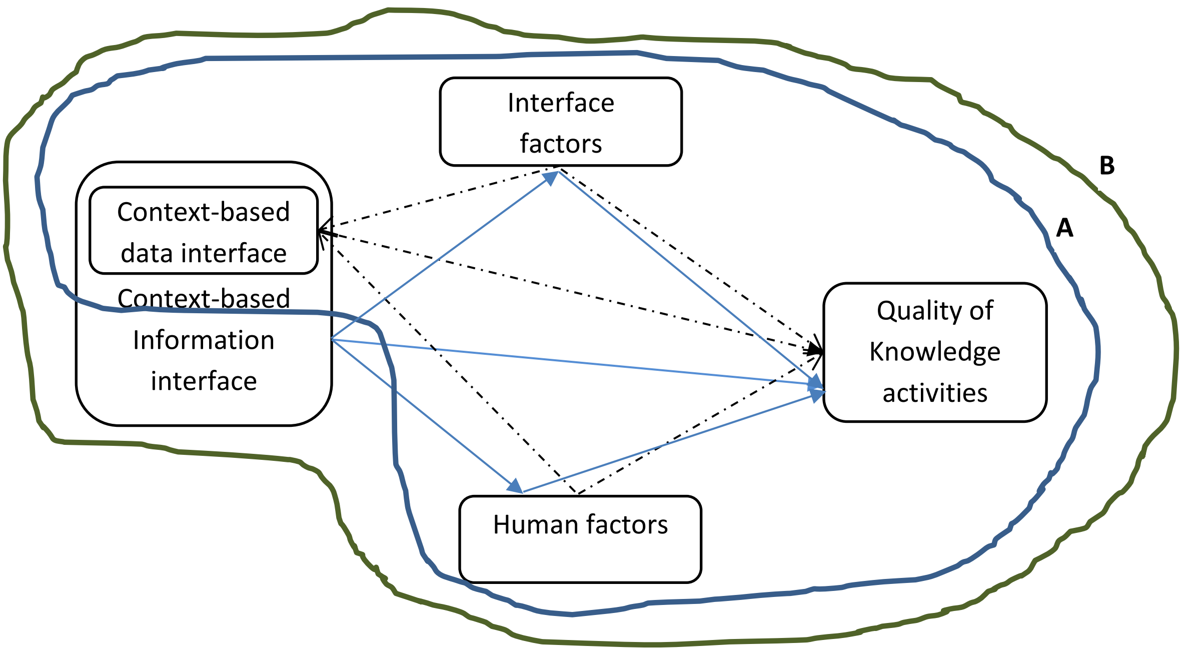


Fig. 7.6: Iterations A, B of context-based interfaces (Quality IS) and knowledge activities

7.4.6 Discussion of the results on the relationship between CBII and KACT

The purpose of the survey and the structural modelling was to ascertain if the design and use of context-based interfaces to store data and retrieve information from IS/IT systems would have any significant impact on the quality of knowledge activities. The results confirm the effect of context-based information interface on knowledge activities (Baskerville & Dulipovici 2006). Therefore, the hypothesis that the design of context-based information interface would have a significant positive impact on the quality of knowledge activities was supported. The results is consistent with the assertion that knowledge activities depends on context (Kanehisa et al. 2014; Kyoon Yoo et al. 2011). The importance of designing software to support context-based information for knowledge activities (Cases et al. 2013) was confirmed by the study. The findings reiterates the view of Davenport et al. (2012) that "Next-generation IT processes and systems need to be designed for insight, not just automation.". Insight is dependent on context, therefore the design of context-based interfaces that yield context-based information are imperative for the design of future IS/IT systems.

The results showing the significant relationship between human user and knowledge activities is consistent with Dzandu et al. (2014) who reported significant relationship between environmental factors and knowledge sharing among university students. The significant mediating effect of the human user in knowledge activities observed in this study re-emphasises the critical role of humans as knowledge agent (Baskerville & Dulipovici 2006) and demonstrated further, the inseparability of culture, human user and knowledge activities (Baskerville & Dulipovici 2006).

7.4.7 Evaluation of the results on the relationship between CBII and KACT

The structural model on the relationship between CBII and KACT has confirmed that indeed the design of context-based information interface has implications for the quality of knowledge activities. Given that this was the second iteration based on the iteration at the data layer, there is evidence to suggest that context-based data interface has implications for context-based information interface and potential a context-based knowledge interface. Thus, the storage of context-based data through context-based IS interface would guarantee the availability of context-based information when the data is eventually retrieved for information activities. Although the evaluation of the relationship between CBII and KACT validates the HII framework at the information layer, the same cannot be assumed for the knowledge layer. It is therefore necessary to validate the HII framework at the knowledge level by modelling the relationship between CBKI and KACT.

7.4.8 Conclusion on the relationship between CBII and KACT

One of the objectives of the study, which was, to ascertain the impact of context-based interfaces on knowledge activities was has been partly achieved. Through this quantitative survey, and the results from the structural modelling, the utility of the HII framework at the information layer of the DIK pyramid has been demonstrated. Using hypothetical scenario, with context-based information interface as a proxy for quality IS, the potential impact of context-based interfaces on the quality of knowledge activities has been demonstrated. The importance of human user and interface factors in the human information interface process were demonstrated through assessment of how these moderate the impact of context-based interfaces on information and knowledge activities.

The results showed a significant relationship between context-based information interface and knowledge activities. The indications are that improved interface design will positively impact on the quality of knowledge activities. This also implies that the quality of data, information and knowledge found in IS/IT systems could benefit from storing more context details about the phenomenon the sign (data) represents in the IS/IT systems. Additionally, aside the design of context-based interfaces for IS/IT systems, it is important to understand how human factors (e.g. individual culture) and some components of the interface influence the storage of the data, the meaning of information and usability of the knowledge thereof. The study confirmed the significant mediating effect of individual culture on the relationship between context-based information interface and knowledge activities. Therefore, the HII framework has been validated at the information layer through measurement and structural modelling.

Knowledge is actionable information, and in order to complete, the evaluation of the HII framework at the knowledge level, the outcome of the validation of the CBII and KACT, serves as input for evaluating the framework at knowledge level. The next section therefore evaluates the relationship between CBKI and KACT.

7.5 Evaluation of the relationship between CBKI and KACT

This section validates part of the HII framework focusing on the knowledge interface. An experimental questionnaire is used to assess the expectations of the respondents with respect to building context-based information interfaces for IS and their perceptions about the potential impact of the interface on knowledge activities. The hypothesis tested is that "the design of context-based information interfaces would have a significantly positive impact on the quality of knowledge activities". Context-based information interface is used a proxy for quality IS. The assumption is that quality of IS (in the form of context-based interfaces) will ensure the storage of context-based data so that when users retrieved data from IS/IT systems, it will guarantee the availability of context-based information and knowledge to engage in improved knowledge activities.

7.5.1 Research Method and Procedure

The method used for this iteration was similar to the previous two sections. The questionnaire had four sub-sections namely context-based knowledge interface (six factors on quality of knowledge from IS were used as a proxy), interface factors, knowledge activities and individual culture/human factors (HF). The CBKI and interface factor constructs were measured with nine items each whilst knowledge activities and individual culture were measured with eight and sixteen items respectively. Each item had a 7-point Likert-scale response option (Oates 2006; Olivier 2004; Zikmund et al. 2013) and the questions were clearly stated, unambiguous and very easy to answer (Rogers et al. 2011; Myers 2009). The key constructs, items and sources of the questions are shown in Table 7.15.

Table 7.15: Constructs used in the SEM questionnaire

Constructs	**Items**	**Source**
Context-based knowledge interface (CBKI)	Adaptable, applicable, expandable, true, justified, Innovativeness	Wang & Strong (1996); Sasidharan et al. (2012)
Interface factors	Intention, acquisition, usability	Marchionini (2008); Barron et al. (1999); Stamper (1996); Ong & Lai (2007); Kraaijenbrink & Wijnhoven (2006)
Knowledge activities (KACTs)	Acquisition, capturing, storing, reusing, externalising, stimulating, identifying new knowledge, and leveraging of knowledge	Matusik & Heeley (2005); Lai & Lee (2007); Beesley & Cooper (2008); Sowe et al. (2008); Lew & Yuen (2014); Lew et al. (2013)
Individual culture	Collectivism, uncertainty avoidance, long-term orientation.	Yoo et al. (2011)

The questionnaire was designed and mounted online using Qualtrics software. Group as well as personal emails were sent to potential respondents from my address book to respectfully request their assistance in completing the survey via a web link. In addition, invitations were sent to potential respondents via other social media and online platforms such as WhatsApp, LinkedIn, Facebook and member list of IT professions in the UK. Although the link to the survey was left open for longer period, data collected as at the end of the 3rd month were used for the analysis. The pre-coded data was downloaded in a CSV file format and cleaned by removing incomplete and no response data. In all a total of 254 responses were imported into the SmartPLS software for analysis.

7.5.2 Results - Assessment of the measurement model

A dataset with 254 valid responses from the online survey experiment was used for the structural equation modelling (SEM). The SEM steps (as in 7.4) were repeated to evaluate the impact of CBKI on KACT with HF and IF as mediators. The results of the multicollinearity diagnostics test for the second-order items yielded VIF's less than 5 (Hair et al. 2017).

Table 7.16: Multicollinearity diagnostics test for the second-order items

Constructs item	VIF
ACQ1	1.617
ACQ2	2.526
ACQ3	2.547
COI1	3.582
COI2	3.438
COI4	3.840
COI6	3.002
INT1	1.293
INT2	1.728
INT3	1.881
KACT1	2.458
KACT2	2.734
KACT3	2.457
KACT4	4.007
KACT5	3.751
KACT7	3.279
KACT8	2.837
LOI1	2.306
LOI2	1.862
LOI3	2.756
LOI4	2.916
LOI5	2.643
LOI6	2.851
QOK1	3.317
QOK2	3.551
QOK3	3.028
QOK4	2.044
QOK5	2.337
QOK6	1.712
UAI1	2.653
UAI3	3.344
UAI5	3.453
USA1	1.603
USA2	1.894
USA3	1.547

In addition, all the items loaded very well as shown in the cross loadings in Table 7.17.

Table 7.17: Factor loadings of the items

Items	ACQ	COI	INT	KACT	LOI	UAI	USA
ACQ1	0.806						
ACQ2	0.907						
ACQ3	0.887						
COI1		0.914					
COI2		0.899					
COI4		0.919					
COI6		0.882					
INT1			0.735				
INT2			0.833				
INT3			0.875				
KACT1				0.816			
KACT2				0.843			
KACT3				0.821			
KACT4				0.870			
KACT5				0.869			
KACT7				0.852			
KACT8				0.822			
LOI1					0.826		
LOI2					0.755		
LOI3					0.853		
LOI4					0.863		
LOI5					0.830		
LOI6					0.842		
QOK1						0.879	
QOK2						0.880	
QOK3						0.868	
QOK4						0.737	
QOK5						0.807	
QOK6						0.674	
UAI1						0.907	
UAI3						0.926	
UAI5						0.929	
USA1							0.830
USA2							0.876
USA3							0.796

Also, all the Cronbach alpha and the composite reliability values were greater than the recommended mark of 0.70 (Churchill 1979; Ain et al. 2016; Chong et al. 2018) as shown in Table 7.18. Therefore, multicollinearity was not a major issue in this model and the measurement constructs were reliable.

Table 7.18: Reliability and validity test results

Items	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
ACQ	0.835	0.843	0.901	0.754
CBKI	0.896	0.925	0.920	0.658
COI	0.925	0.926	0.947	0.816
HF	0.930	0.931	0.939	0.543
IF	0.889	0.892	0.911	0.533
INT	0.747	0.756	0.856	0.666
KACT	0.932	0.933	0.945	0.709
LOI	0.908	0.910	0.929	0.687
UAI	0.910	0.910	0.944	0.848
USA	0.782	0.787	0.873	0.697

The observed AVE values (Table 7.18) were greater than the recommended threshold of 0.50 (Fornell & Larcker 1981; Ab Hamid et al. 2017; Chong et al. 2018). Therefore, discriminant (Table 4.19) and convergent validities were confirmed for the measurement model.

Table 7.19: Results of Fornell-Larker Criterion for discriminant validity

Construct	ACQ	CBKI	COI	HF	IF	INT	KACT	LOI	UAI	USA
ACQ	0.868									
CBKI	0.025	0.811								
COI	0.162	0.029	0.903							
HF	0.372	0.143	0.073	0.737						
IF	0.469	0.022	0.195	0.356	0.730					
INT	0.668	0.028	0.102	0.265	0.890	0.816				
KACT	0.374	0.196	0.535	0.301	0.398	0.352	0.842			
LOI	0.395	0.164	0.507	0.404	0.392	0.349	0.666	0.829		
UAI	0.356	0.156	0.497	0.827	0.270	0.153	0.531	0.662	0.921	
USA	0.574	0.004	0.243	0.284	0.450	0.661	0.308	0.271	0.182	0.835

The full collinearity test results showed for the latent constructs revealed VIF values < 5; and also less than 3.3 (Chong et al. 2018) as shown in Table 7.20.

Table 7.20: Full collinearity test results

Constructs	VIF Values
CBKI	1.022
HF	1.170
IF	1.146
KACT	1.000

Therefore, lateral collinearity was not an issue in this model; and the model does not suffer significantly from common method bias. The assessments of the measurement model did not reveal any significant concerns in relation to multicollinearity, reliability, validity of the measurement model and common method bias. Therefore, the measurements can confidently be used to model the relationship between CBKI and KACT with IF and HF as mediators.

7.5.3 Assessment of the structural model (path analysis)

The outcome of the path analysis first revealed a very good fit between the data and the structural model. The model was significant in explaining 52.1% (R^2=0.521) of the variance of the dependent variable (KACT). The significance of the relationships between the constructs were then assessed through path coefficients (Fig. 7.7 and Table 7.21).

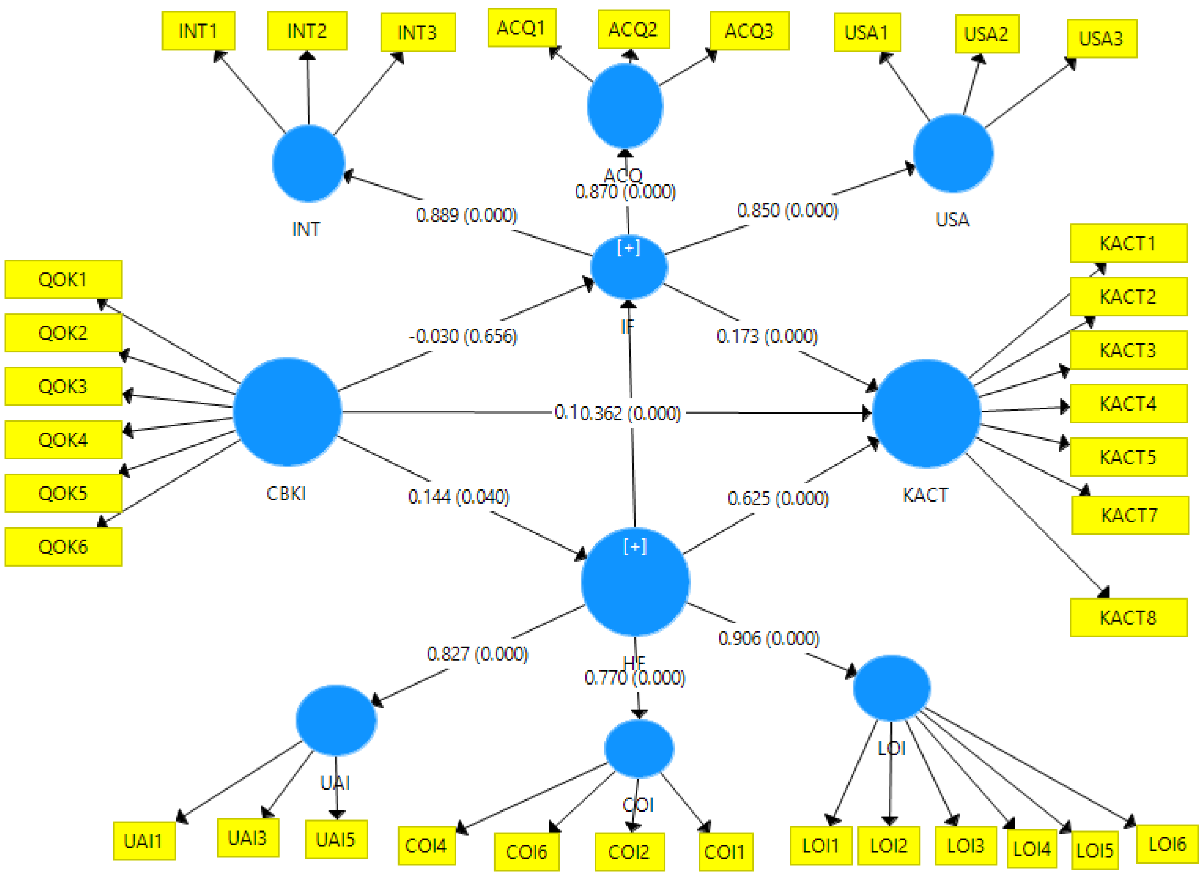


Figure 7.7: Output of the Research Model for CBKI and KACT

The results (Fig. 7.7) of the path analysis showed significant relationship between CBKI and KACT (β=0.010, $p<0.05$) but the relationship between CBKI and IF was also not significant (β=0.022, $p>0.05$). However, both IF (β=0.173, $p<0.05$) and HF (β=0.624, $p<0.05$) exhibited significant relationship with KACT.

Furthermore, the joint mediation effect of IF and HF on the relationship between CBKI and KACT was not significant (β=0.009, $p>0.05$). However, given that the mediation effect of IF (β=0.014, $p>0.05$) on CBII and KACT was not significant, but HF (β=0.304, $p<0.05$) was significantly related to IF, and IF (β=0.162, p<0.05) was significantly related to KACT, the indications are that the mediation effect was largely due to HF (β=0.604, p<0.05) as shown in Table 7.21. Thus, HF accounted for 96.3% of the mediation effect of CBKI on KACT.

Table 7.21: Path coefficients for direct and indirect effects for CBKI, IF, HF and KACT

Paths	Original Sample (O)	Sample Mean (M)	Stand Dev (STDEV)	T Statistics (|O/STDEV|)	P Values
CBKI -> HF	0.143	0.151	0.067	2.127	0.034
CBKI -> IF	0.022	0.031	0.069	0.323	0.747
CBKI -> KACT	0.103	0.106	0.052	1.994	0.047
HF -> IF	0.362	0.365	0.084	4.308	0.000
HF -> KACT	0.624	0.623	0.049	12.634	0.000
IF -> KACT	0.173	0.176	0.044	3.945	0.000
CBKI -> IF -> KACT	0.004	0.006	0.013	0.296	0.768
CBKI -> HF -> KACT	0.090	0.097	0.038	2.378	0.018
CBKI -> HF -> IF -> KACT	0.009	0.010	0.007	1.378	0.169

These results re-emphasis the significance of human user in achieving optimum understanding and usability of information retrieved from IS/IT systems for knowledge. The results also underscore the importance of human interface with information and the almost negligible role of IS/IT in the face of the disappearing computer. Fig. 7.8 shows the third iteration, C (context-based knowledge interface) and how it has been develop based on the previous iterations A and B. Iteration C represents quality information systems and how it impact on the quality of knowledge activities.

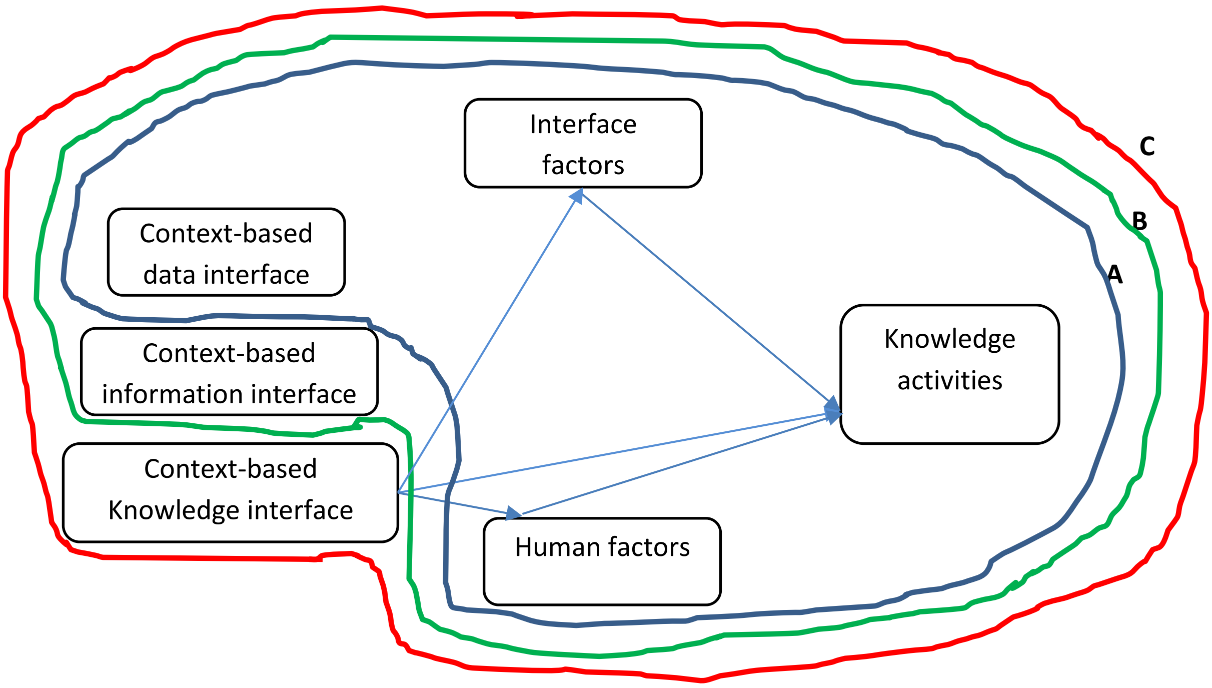


Fig. 7.8: Iterations A and B of Context-based Interfaces (Quality IS) and Knowledge Activities

7.5.4 Discussion

The purpose of the structural model in this section was to ascertain if the design and use of context-based knowledge interfaces for IS/IT systems would have any significant impact on the quality of knowledge activities. The results confirm the effect of context-based knowledge interface on knowledge activities (Baskerville & Dulipovici 2006). In other words, quality IS interface denoted by the design of CBKI have implications for the quality of knowledge activities. The results thus confirm the hypothesis that "there will be a significantly positive relationship between CBKI and the quality KACTs. This confirms that indeed knowledge activities are dependent on context (Kanehisa et al. 2014; Kyoon Yoo et al. 2011).The importance of designing software to support context-based data and information for knowledge activities has been emphasised in extant literature (Cases et al. 2013). The findings reiterates the view of Davenport et al. (2012) that "Next-generation IT processes and systems need to be designed for insight, not just automation". An adequate consideration of context is therefore required to ensure the effective and efficient use of the stored data, information and knowledge (Poston & Speier 2005; Kyoon Yoo et al. 2011).

The results showing the significant relationship between human user and knowledge activities is consistent with studies by Baskerville & Dulipovici (2006) and Dzandu et al. (2014) who reported significant relationship between culture, human user and knowledge activities. The results further re-emphasised the critical role of humans as knowledge agents and in knowledge activities (Baskerville & Dulipovici 2006). The role of mediators and moderators in knowledge activities are well documented (Hwang & Lee 2012; Brazier et al. 2000) especially that role of humans. For example, a knowledge engineer and an expert user, often mediate representations in expert systems based on the shared tasks model (Brazier et al. 2000).

7.5.5 Evaluation of the Structural Models for the HII Framework

One of the objectives of the study, which was, to ascertain the impact of context-based interfaces on knowledge activities was has been partly achieved. Through this quantitative survey, and the results from the structural modelling, the validity of the HII framework has been partly demonstrated. Using hypothetical scenario, with proxies for context-based data interface and context-based information interface, the potential impact of context-based interfaces on the quality of knowledge activities has been demonstrated. The importance of human user and interface factors in the human information interface process were demonstrated through assessment of how these moderate the impact of context-based interfaces on information and knowledge activities.

The results showed a significant relationship between context-based data interface and context-based information interface and knowledge activities. The indications are improved interface design will positively impact on the quality of knowledge activities. This also implies that the quality of data, information and knowledge found in IS/IT systems could benefit from storing more context details about the phenomenon the sign (data) represents in IS/IT systems. Additionally, aside the design of context-based interfaces for IS/IT systems, it is important to understand how human factors (e.g. individual culture) and the components of the interface influence the storage of the data, meaning of the information and usability of the knowledge thereof. The study confirmed the significant moderating effect of both individual culture and interface factors on the relationship between context-based interface and knowledge activities. Therefore, the HII framework has been validated through measurement and structural modelling.

The limitation of the evaluation of the HII framework through quantitative models is the inability to assess the applicability and potential utility of the proposed framework something, which are more suited to qualitative evaluation through interviews and case studies.

7.5.6 Conclusion

The results from the structural equation modelling revealed significant relationship between context-based IS and knowledge activities. Thus, improved IS interface design in the form of context-based data-interface (CBDI), context-based information interface (CBII) and context-based knowledge interface (CBKI) all have significant positive impact on knowledge activities (KACT). The result demonstrates the potential validity of the HII framework showing how the design of quality IS systems in the form of context-based interfaces would enhance the quality of knowledge activities when data is retrieved from IS/IT systems. This will in no doubt reduce some of the misconceptions about the true value of knowledge derived from stored data in IS. The results in this section, which provides empirical validation of the HII framework through structural modelling, serve as a basis for further qualitative evaluation through expert reviews in the next section.

7.6 Evaluation of the HII framework through Expert Reviews

In this section, qualitative interviews with experts are used to evaluate the validity, applicability and utility of the HII framework since all these were not possible in the quantitative evaluation in the previous sections. For example, since it was not possible to assess the applicability and potential utility of the proposed framework through quantitative methods, the qualitative methods are used. The purpose of the expert interviews therefore was to gain insights and real live opinions from practitioners who were asked to provide illustrative case studies to demonstrate the utility and applicability of the framework.

7.6.1 Method and Data Analysis Procedure

Qualitative interviews (Myers and Newman 2007; Yin 2008) were held with six experts to assess the validity, utility and applicability of the HII framework. The experts used their organisations as case studies to demonstrate the applicability and utility of the HII framework. The expert reviewers were made up of a Research Scientist with the NHS, UK; a Business Intelligence and Analytics Consultant who also doubles as a Sessional Lecturer in Data Mining and Business Intelligence at a University in UK (Appendix 6). There was also a Software Engineer and Researcher from Chile; and Security Information Analyst from the United Arab Emirates who are all currently pursuing further research degrees in Universities in the UK. The remaining expert reviewers were an IT Manager at a Financial Market institution in Ghana, and a Research Analyst of a Data Solutions firm in the UK (Appendix 6).

The expert reviewers were purposively selected for the study because of their extensive professional and academic background and experience in data and information analytics, systems development, research, accounting, and software development roles. The ethnic diversity of the expert reviewers brings some cultural richness to the data. The mode of data collection was face-to-face with five out of the six expert reviewers who were all available and accessible in the UK. The interview with the IT Manager of a Stock Exchange in Ghana was conducted over skype. In all cases, the consent of the interviewees were first sought, after which a copy of the HII framework together with a list of three main questions and two sub-questions were sent to the interviewees (Appendix 7). Dates and time were agreed and fixed for the interviews. The questions were structured around three key themes namely validity, applicability and that helped to control the interview scope and range of responses.

The interviews were held in various locations depending on the interviewees' convenience but mostly in the Informatics Research Centre seminar room at the University of Reading, UK. Most parts of the interviews questions had been typed written or answered on the template by the interviewees but were re-echoed at the interview sessions. Although, it was meant to be structured interview, where necessary additional questions were asked during the face-to-face interview sessions to clarify any ambiguities. The interviews were recorded and transcribed for the purpose of cross checking the responses with the type written answers and to update their initial typewritten answers.

The data analysis procedure for the qualitative data follows the six phase thematic analysis process (Braun & Clarke 2006). This includes familiarisation with the data during transcription where the recorded responses were replayed several times and initial ideas were noted leading to the second phase of generating initial codes. The codes were collated into themes (i.e. validity, applicability and utility. The fourth and fifth phases involved the reviewing of the themes and refining of the themes to tell the overall story. All these were accomplished using NVivo 10. The last phase of the process was the presentation of the results as shown below. The thematic analysis made it easier to control the scope of the interview and the responses whilst providing evidence of the expert interviewee's response to the particular issue.

7.6.2 Results

The results from the analysis of the interviews have been presented under three sections namely validity, utility and applicability. The questions, which served as the themes, are presented and supported with the necessary quotes by the interviewees.

7.6.3 Evaluating the Validity of the HII framework

In addition to the results from the quantitative survey to assess the potential impact of context-based data, information and knowledge interfaces on knowledge activities, expert reviews were used to further ascertain the validity of the HII framework. The experts' reviewers responded to question the question as to whether the HII framework was valid. In response, all the experts affirmed the legitimacy of the HII framework. Some of opinions expressed were:

> *"This framework is clear and offers an improved approach to how to deal with the issue of context which is a huge problem in industry. Whilst it is a known problem, it has been difficult for practitioners to come up with a solution. Theoretically, the problem is easy to talk about but practically difficult to get examples to demonstrate. This framework however simplifies the problem in terms of identifying what defines context of data making it much easier for information modelling to support business activities".* (BI and Business Analytics Consultant, Consulting firm, UK).

> *"the framework is valid, and it clearly shows what businesses need (context) and how they can use IS to leverage the richness of data through predictive analytics, machine learning to deliver value to clients. It will help businesses to understand their ecosystems better".* (Research Analyst, Data Solutions Company, UK)

> *"The framework makes absolute sense and can easily be followed and understood". Absolutely……..it will help AI models to be built easily on "how" and "why" databases to provide semantic models more comprehensively than before. Context is a major or key underlying factor for knowledge".* (Research Scientist, NHS, UK).

"Yes, the framework to me is valid as it clearly shows the need to collect context of data for input into IS so that more understanding or insights can be derived from it when it is retrieved. I can relate the framework to my research on building flexible information systems and a larger research project in Chile where attempts are being made to build some smartness or intelligence into physical devices using Raspberry Pi and Arduino as current capabilities of physical devices cannot make intelligence". (Software Engineer, Consulting, Chile).

The expert reviewers were unanimous in their assessment of the validity of the HII framework. Not only did the expert reviewers confirmed the validity of the HII framework, they affirmed its relevance in information system development as well as implications for artificial intelligence, predictive analytics, and machine learning among others. The problem of missing context in stored data in IS were re-emphasised by the interviewees and the framework was considered as an approach to dealing with context issues in data and information activities. Thus, although the framework was not practically implemented during the life of this research, all the expert reviewers affirmed its validity. The next section reports the evaluation of HII framework for potential utility.

7.6.4 Evaluating the Utility of the HII Framework

In order to assess the potential utility of the HII framework, the opinion of the expert reviewers was sought on the practical viability of the framework. In responses all the experts unanimously agreed that the framework can be utilised in the design of interfaces for IS/IT systems. They also affirmed that it can be utilised in the design of databases by extending the current approach to the design of meta-data to support databases.

"I think the framework can easily be utilised in the design of database models for business activities and can be applied in data analytics, business analytics and intelligence among others. Above all it can, particularly, be used in IS design, information modelling and requirement analysis for the design of information products and business services" (BI and Business Analytics Consultant, Consulting firm, UK).

"The framework is absolutely clear……and it can be used especially in business management" (Research Scientist, NHS, UK).

"It can be utilised by businesses to define and design appropriate information systems and data models. For example, this framework can be aligned with the vision, mission, business model and strategies and objectives of my company and allows us to capture detailed data to enable us deliver improved data solutions and value to our clients." (Research Analyst, Data Solutions Company, UK)

The evidence from the interviews with the expert reviewers suggest that the HII framework can be utilised in several domains. The next section reports how the HII framework was evaluated for applicability.

7.6.5 Applicability of the HII Framework

The applicability of the HII framework was gleaned from the responses in the main interviews and from the expert reviewers, some of whom used scenarios from their work settings as case studies to demonstrate the applicability of the HII framework.

> *"The framework can be applied in various sectors in industry, especially in the areas of business management and it will definitely enhance business decision making. Also, it can be used in applied in machine learning and natural language processing situations where context is the key issue. Certainly, it can help reduce the cost of training machine, as the current cost on training data for machine learning purposes is very high."* (BI and Business Analytics Consultant, Consulting firm, UK).

> *"In most recent years, organisations such as Amazon, eBay, etc and high business marketing organisations have embarked on projects related to context – about person/clients. Context is very important but in industry, key context issues aren't clear enough to help managers to decide on what to do to improve their businesses. So yes, the framework can be applied in high level business marketing organisations"*. (Research Scientist, NHS, UK).

> *"……it will transform the way a lot of things are done in various sectors and aspects of live and work; from education and learning, medicine, air travel, package deliver, transportation among others."* (IT Manager, Stock Market, Ghana).

Some of the expert reviewers demonstrated how the framework could potentially be applied to deliver business value, improve decision making, save cost whilst enhancing the predictive capabilities and intelligence of computer systems, AI and machine learning. The illustrations of the potential applicability of the framework are reported as case studies (with scenarios in some cases).

> *"Yes, it is can be applied in my work situation as it will allow our clients like Amazon, e-bay etc. who buy data from us and use these to improve their online service to their customers"* (Research Analyst, Data Solutions Company, UK)

The illustration of how the framework could be applied in the context of the research analyst who works for a data solutions company in the UK is captured as case study 1.

Case study 1: Delivery value in a business ecosystem using context-based data

> *"My company provides data solutions to high-end online organisations, who rely on us to sources for more details about some devices clients use to access their services. The data we provide to them helps them to understand the customers better through predictive analytics. These high-end online firms use the data to optimise their websites to enhance the service experience of their customers. As I said before we collect about 140 fields of details about a mobile device, basically the properties and characteristics of the phone which can be described as the "what" as per your framework. The "why" about the phone depends, but it could be business or organisational driven, so why do we collect this data, because that is our business model, and for the high-end organisation we sell the data to, why the need these, is because they want to create value for their customers.*
>
> *Clearly, they come to us because there is lack of details or context about the mobile device which affect their ability optimise their websites to deliver seamless user experience for their client. Yes, there is a huge problem with context of data or information in industry and that is what our company seeks to address. However, the data we collect only represent a fraction of the context of data on the mobile device within the larger business ecosystem of our clients. Although, we collect about 140 fields of details these are simply data about data or call it meta-data about the phone. It only helps to describe the phone (i.e. the what) but with these our clients are able to optimise their websites and information systems to be able to identify "who" accessed their services; from where "location". And together with IoT and sensors that can detect other context details about "how" or user behaviour based on their gestures, etc.; and make some prediction about "why" client need, would need some services and make recommendations to the clients. However, it must be noted the real reasons why their customers access certain services or not can only be sourced from the customer; and that certainly is perhaps what you are calling the human information interface".* (Research Analyst, Data Solutions Company, UK).

Sharing his opinion on the potential applicability of the HII framework, the Security Information Analyst had this to say;

> *"the framework would be very applicable to the security industry for the purpose of investigating incidents. Usually the purpose of conducting investigations after an incident is to know "how" the incident happened and "why" it happened. In our work as security personnel, information analysis is very crucial and the reason why we do investigation is to know "why" an incident happened and "how" it happened so as to respond appropriately and promptly. With this framework, more meaning can be derived from stored data and machine can easily*

understand and aid investigation…………certainly AI interfaces are sure to benefit from this". (Security Information Analyst, Security Sector, UAE).

The illustration of the application of the framework in security situation is reported as case study 2 with 2 scenarios (Fig. 7.9).

Case study 2: Scenario 1: Private Security Guard in a Hospital Setting – Incident with someone

"The framework can definitely be applied in security sector and in my work role. For example, assuming there is an incident at a hospital with someone (e.g. patient, etc) and there is the need for investigation, if the private security guard stationed at a hospital can provide some context details such as the who, what, why, how, when, and where, it is possible even for computerised systems to understand the context of the incident and trigger further investigation, or even come up with potential cause of the incident".

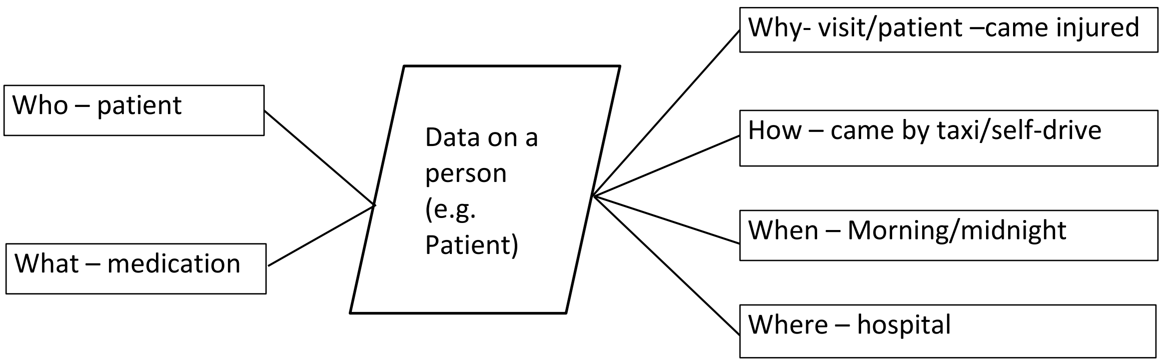


Figure 7.9: Context-based data for security investigation in a hospital

"*As you can see, I consider the "situation" as implicit in the other context details, in this case the "who", "what", "why", "how", "when", and "where" defines the situation and this situation may change. However, the incident could be considered one situation of the incident; only data is available (call it the start situation). Then when the data is analysed and passed on by the security guard, that is another situation of the data (call it situation 2) where the data has acquired more value or meaning. Then the end situation is where an action is taken, and knowledge and experience are heavily relied upon and applied (call it the end situation). So, like the information pyramid, "situation" might be conceived as the different states of an incident, data or event similar in value to data (less meaning); information (meaning) and knowledge (much more meaning)."* (Security Information Analyst, Security Sector, UAE).

Case study 2: Scenario 2: Context-based Information sharing for Security Investigation

"Another scenario where the framework can be applied in my work settings could be when competent authority seeks to understand the clear picture of an incident handled by a private security guard (PSG). Let's say a PSG on duty at the University Library, and there

is someone moving around with a knife very late in the night. The typical set-up is as explained to you before, has four actors (could even be 5 actors if the incident is reported to the PSG by someone else)". (Security Information Analyst, Security Sector, UAE).

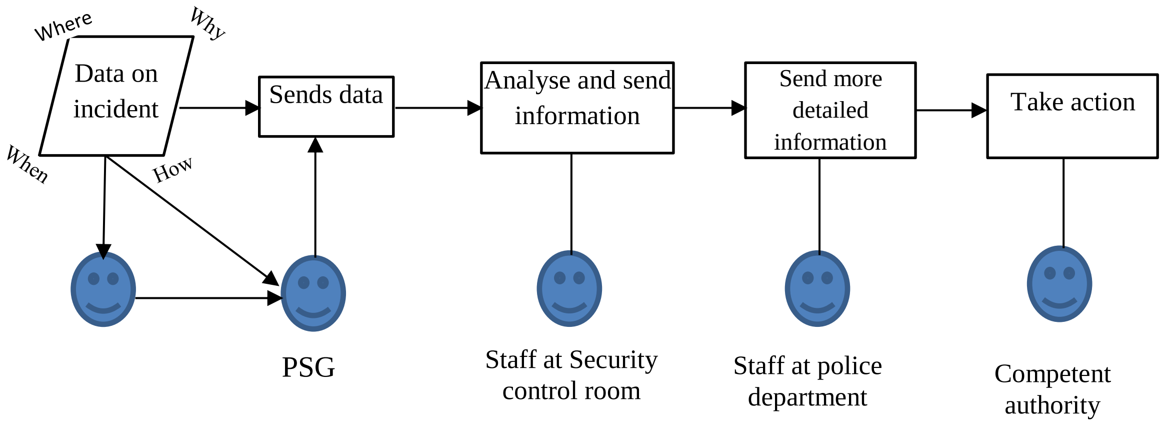


Figure 7.10: Context-based security information sharing for investigation

"*What will happen with the potential application of the framework, once the context details are captured and stored by the PSG, then all the other Actors can really understand the context of the incident, especially the competent authority get a clear picture of the incident for strategising. Also, with the context details especially knowing the "why" about the incident, the computer can be programmed to be more intelligent using AI to understand the incident and automatically trigger the appropriate actions. With this, it will help take the right decisions, reduce mistakes and save time."* (Security Information Analyst, Security Sector, UAE).

The interviewees also pointed out some issues, which they considered as challenges to the applicability and implementation of context-based interfaces.

"There are however some potential dangers associated with context-based IS/IT systems deployments since it has potential to cause global chaos when these systems fail. Care must be taken to provide contingencies deployments in the design of context-based systems". (IT Manager, Stock Market, Ghana).

"Like I said somewhere, the framework is clear and valid, but it may not be applicable in all situations. For instance, depending on the purpose of an IS/IT system or the needs of the system owner, there would be no need for context details to be captured". (Research Scientist, NHS, UK).

"Cost could be a major challenge; developing software to support such systems can be expensive. Aside that its implementation can also be challenging as it will require a change in organisational culture and employees would be resistant to the change especially as it will require more effort from them in terms of capturing more details into the IS/IT systems". (Security Information Analyst, Security Sector, UAE).

It can be gleaned from the responses that the interviewees considered the HII framework as valid, applicable and used case studies of their professional work activities to demonstrate the potential utility of the framework. Based on the assessment of the potential viability of the HII framework from the case studies by the expert reviewers, their opinions were sought on ways to improve on structure, features, design and functionalities of the HII framework. The next section outlines the key suggestions by the expert reviewers, which served as a basis for optimising the initial HII framework (see Chapter 6).

7.7 Suggestions for Improvement of the HII Framework

The opinions of the experts were also sought on areas of improvement of the framework. In response, the expert reviewers offered suggestions on how the HII framework could further be improved. The following were their major suggestions for consideration:

1. *"There is the need to link the meta-store to the "IS" before the data retrieval activity takes place. Else, the framework does not show that the data is stored in the IS/IT system. For consistency sake, it will be good to refer to the "meta-data" as "meta-what" just so it is consistent with your proposed "meta-how" and "meta-why"; and call the entire storage component as "meta-store". Perhaps call the "meta-what" factual data and consider renaming the "context data" as "contextual data" based on the suggestions of Kimble and Chandler. Also, if you can adjust the structure of the framework to follow the typical information pyramid where data issues (syntactic layer) will be the base or foundation on which the semantic (information) and pragmatic (knowledge) layers are anchored. Thus, let the syntactic layer sits at the base; followed by the semantic layer where information activities take place; and the pragmatic layer where knowledge activities usually happen similar to the pyramid. In addition to this, you may wish to relook at the structure in phases -from the environment, to the semiotic phase, the IS phase, then the meaning making or information phase, and finally knowledge phase."* (BI and Analytics Specialist, Consulting, UK).

2. *"Perhaps consider changing "human actor" to "expert system", I think expert system fits the bill more, if you are talking about intelligent interfaces for IS/IT systems. Also, the data could be collected automatically into the systems using sensors, in which case you can have two sources of the data capture into the IS/IT system, the human actor or expert systems and sensor-based systems. Also, consider linking the IS to storage (meta-store) and perhaps call it "context-store".* (Research Scientist, NHS, UK).

3. *"I am a bit concern about the "situation" as a component of context. In my view, all the other components i.e. the "what", "who", "when", "where", "how" and "why" define the situation. So, for example, in my work scenario, when an incident happens, and the PSG send data to the security*

information room or the control room this could be termed the data level and that is situation 1 or call it the "start situation". When the data is analysed, and information is passed on to the appropriate security unit (police, fire brigade, etc), that is the information level, call it situation 2. Then when you can talk about the end situation as when the appropriate security unit acts on the information to deal with the incident, which is the knowledge level. To me another contribution of the framework is a method for understanding situational analysis where context details helps to derive more or increased value or knowledge from the previous situation." (Security Information Analyst, Security Sector, UAE).

4. *"I have a problem with "object", I suggest you call it phenomenon, event, or incident. To me data is the abstract of the event, incident, or phenomenon that occurs in the environment to be captured in the IS/IT system. In the context of my work and research in software engineering, the "problem" being solved could be the "situation" or the "situation" could be a process that depends on the workflow. For example, situation could be an event (represented in a state machine which describes the "how" aspect of the data though not all the how details are possible to define); or "profile" which could represent the "who" or identity".* (Software Engineer, Consulting, Chile).

The suggestions from the experts' reviews were considered; however, not all were incorporated in the refined framework. For example, the suggestion to replace the human actor with expert system did not fit in well with human information interface, which was the theme for this study. It is, however, acknowledged that this would have been a good idea if the study had focused on context-based expert systems and artificial intelligence. Therefore, replacing human actor with expert systems would have created some confusion for readers, and diverted the focus of the study from human-information interface to machine-information interface.

7.8 Optimising the HII Framework

The initial HII framework (see Fig. 5.20 in Chapter 6) has been refined following the suggestions from the expert reviewers and upon personal reflections and critical assessment. The improved framework is shown in Fig. 7.8. The main additions are the sensor as an alternative source of capturing data or signals into IS/IT systems. This suggestion was considered because of the availability of technologies such as Internet of Things (IoT), uniquely identifiable objects (things) with Uniform Resource Identifier (URIs), and Radio-frequency identification (RFID) where sensors are used to capture real time data for input into various IS/IT systems for various purposes. Together with various other technologies such as biometric readers, location-based systems, cameras, smart devices (e.g. watches, cameras, drones, etc.), IS/IT systems do not have to necessarily rely on human actors to perceive and capture data into IS/IT systems.

The suggestion to link the "Meta-why" and "Meta-how" layers to the data retrieval activity to generate the factual data leading to context-based data for information and knowledge activities is considered very useful. The idea calling of labelling the meta-data as "meta-what" is for ensuring consistency and simplicity although this does not in any way enhance the functionality of the framework. Similarly, the transition from object, to factual data, to context-based data and contextual information clarifies the level of activity undertaken at each layer. In addition, the label context-store fits the bill and clearly indicates to extend the current structure of database design beyond meta-data to include "meta-why" and "meta-how". This will create room for more context-details to be captured and stored in IS/IT systems to enhance the understanding and usability of data when it is retrieved from IS/IT systems for information and knowledge activities. The refined or optimised HII framework is shown in Fig. 7.11.

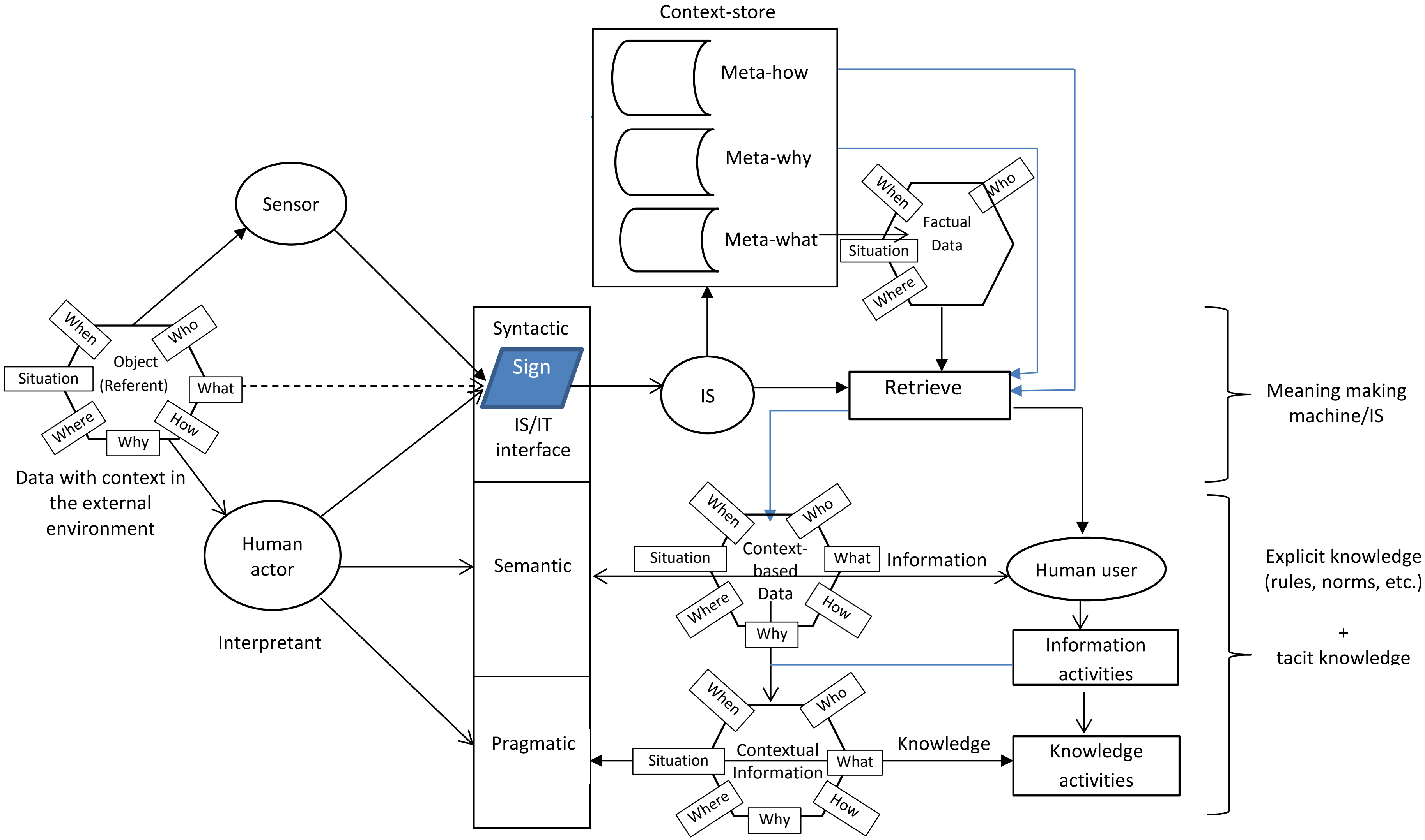


Figure 7.11: Context-based HII Framework for Information and Knowledge Activities

7.9 Chapter Summary

In this chapter, the HII framework was evaluated for validity, utility and applicability. The acceptance of the potential artefact in solving a research problem requires its evaluation by relevant community of academics and practitioners (Hevner et al. 2004). The evaluation of the research involved different stakeholders from various backgrounds and industries. Given the general nature of the research problem, and since individuals, groups of people and the larger society interact with IS/IT systems on virtually daily basis, potentially anyone who uses IS/IT systems to store data and engage in information and knowledge activities is a beneficiary of the outcome of the research. Since it was not possible to design and implement the HII framework during the life of this research, the expert reviewers used hypothetical cases during the interviews to provide empirical evidence of proof of concept of the applicability of the framework.

Using a proxy for context-based data; information; and knowledge interfaces, the validity of the HII framework was evaluated by modelling the relationship between the hypothetical context-based interfaces and knowledge activities. The survey revealed significant impact of the proposed context-based interfaces on knowledge activities with human factors as a significant mediator of the relationship. Although, both IF and HF mediated the relationship between CBDI, CBII and KACT; there was full mediation effect of HF as it accounted for at least 94.2% of the mediation. Furthermore, the utility, validity and acceptability of the framework was assessed through expert interviews. The evidence from both the quantitative and qualitative methods confirmed the efficacy of the HII framework. Therefore, the evaluations of the HII framework helped achieved one of the objectives of study, which was, to determine the extent to which improved data and information interface design impact on knowledge activities. In addition to this, the evaluation helped demonstrate rigour associated with the use of design science research paradigm to produce the artefact.

The evidence from the evaluation of the framework especially from the expert reviews yielded very insightful suggestions, which were used to refine the framework without compromising on the main theme of human information interface. The next chapter provides the conclusion for the entire research to meet the fifth phase of the design science research process.

Chapter 8

Discussion and Research Conclusion

8.1 Introduction

This chapter discusses the results of the study and draws conclusion for the entire study which was aimed at investigating how human information interface impact on knowledge activities from the data stored and information retrieved from IS/IT systems. The study specifically set out to address the following research questions:

1) what are the sources of missing context in data stored and information retrieved from computer-based systems?
2) how does individual culture influence affect data storage and information retrieval from computer-based systems?
3) how can users' pragmatic needs and social context be incorporated into the data, information and knowledge interfaces of computer-based information systems?
4) does a context-based human information interface framework enhance the usability of information from computer-based systems for knowledge activities?
5) to what extent does improved (context-based) data, information and knowledge interface impact on the quality of knowledge activities?

The general discussion of the study is presented next followed by the summary, research conclusion, and contributions. The implications of the results are discussed, and limitations and future research directions are outlined.

8.2 General Discussion

This section discusses the outcomes of the research in relation to literature. The results of the study are situated within extant literature to fulfil the key philosophical underpinnings of the research objectives. The discussion thus addresses the key research questions.

8.2.1 Sources of Context Deficiencies in Stored Data/Information in IS/IT Systems

One of the research questions for this study was what are the sources of missing context and information gaps in stored information in computer-based systems? Many researchers (e.g. Brazier et al. 2000; Anderson 2015; Tenopir et al. 2011, Cappiello et al. 2003) and practitioners have identified context as a significant factor in understanding data, information and knowledge. However, there is a lack of existing model that clearly identifies those components of context, which enhances the quality of data, information and knowledge for knowledge activities. From the systematic literature review, seven components of context emerged. These include (who), objects identity (what), location (where), time (when), user intention (why) and user gesture (how) (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007), and situation (Sowa 2003). Thus, an event, object or phenomenon exist in its entirety in the environment with considerable context details such as “what” it is about (identity), location or “where” it exist, time or “when” it happened, actual intention or “why” it happened; “how” it happened (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007); and the situation (Sowa 2003) under which it happened. The context variables were therefore used to model an object, event or a phenomenon in the environment, which can be perceived, by a user (interpretant) and captured as a data (sign) for storage in IS.

The question that arose therefore was what are the sources of missing context in stored data in IS? The data for the study identified the sources of the problems to the **user** (interpretant) and the **interface** of the IS through which the data is captured. The human actor (user) who perceives and captures the data into the IS/IT system using a reductionist principle (Gibson 1978) is thus a significant source of the problem. The user (interpretant) interact with the source of the phenomenon, event or object in the environment (Wang et al. 2018) and captures this as data or sign into IS in line with the Pierce’s Triad of Semiotics (Pierce 1931-35; Pierce 1982-). Therefore Gibson (1978) and Wang et al.'s (2018) assertion that information about an event, object or phenomenon exist in the environment and is perceived by humans and used for various informational and knowledge activities is confirmed. However, given the complexity of measuring the human factor (user) in this study, individual culture (Yoo et al. 2011) is used as a proxy for human factor (user) as since data, information and knowledge activities are usually carried out at the individual level. Individual culture therefore affects the storage of data and retrieval of information of information for knowledge activities.

Another source of the missing context in stored data in IS/IT systems was the limited nature of current IS/IT system interfaces. The inflexibility and limitations IS/IT systems at the syntactic level is re-echoed by (Brazier et al. 2000) who opined that at the object-level interaction, there is usually a one-sided interaction where there is only exchange of factual information initiated by the system. In other words, users can only enter those context details (particularly the “what”) based on limited specification of strategic preferences set by the systems owners and system designers. The user is not given much opportunity to capture more context details or change the object-level information. The inflexibility of current interfaces of IS was perceived as being a limitation of human computer interaction (HCI) design and synonymous with the technical level of the semiotic framework (Liu 2000). A semiotic inspired human interface model was therefore proposed, and the components were conceived as **interface factors**, which have significant effect on human interaction with data, information and knowledge.

The first research question (i.e. **RQ1**) “what are the sources of missing context when data is stored, and information retrieved from IS” was answered. The findings confirmed the role of the human actor or the person (Brazier et al. 2000; Hofstede et al. 2010; Yoo et al. 2011) and interface factors as the sources of missing context in stored data in IS/IT systems. Since no such previous research was found in literature, the relationship between context-based object, interface factors, individual culture and information object was validated through structural equation modelling to contributes new insights to literature. In addition, this serves as empirical evidence and insights into how context impact on the quality of data, information and knowledge in IS. Individual culture and was measured quantitatively using the CVScale (Yoo et al. 2011). Similarly, interface factors at the syntactic level were also measured quantitatively.

The results showed significant relationship between context-based object and the quality of data stored in IS. In addition, the results revealed that human factor (individual culture) and interface factors had significant mediation effect of about 94.5% for the relationship between context-based object and quality of data stored in IS. The results at the data-level were used to develop a context-based data interface artefact, which were then carried forward to develop and validate similar artefacts at the information (chapter 5) and knowledge (chapter 6) levels of the DIK pyramid. The final artefact was the HII framework (chapter 6).

Based on the evidence from literature and the structural models, we defined “Context-based data” as data that include details about user identity (who), objects identity (what), location (where), time (when), user intention (why) and user gesture (how) (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007), situation (Sowa 2003) of the data at the point of storage in IS/IT systems. Similarly, we define “Context-based information” as information that include details about the user identity (who), objects identity (what), location (where), time (when), user intention (why), user gesture (how) (Jang & Woo 2003; Abowd & Mynatt 2000; Truillet 2007), and the situation (Sowa 2003) under which the information occurs or is retrieved from IS/IT systems.

Given that the outcomes of the structural models affirms the significance and mediating role of human factor in knowledge activities which was consistent with literature (Hwang & Lee 2012; Brazier et al. 2000). The study then set out to ascertain how individual culture affect data storage and information retrieval, and knowledge from IS with respect to knowledge activities.

8.2.2 Individual culture and information activities in IS/IT Systems

The second research question (i.e. **RQ2**) was "how does individual culture influence affect data storage and information retrieval from computer-based systems? Individuals usually carry out data, information and knowledge activities. The influence of individual culture on data storage and information was ascertain based on the assumption that the "sign" represented in IS/IT systems is done by an individual from their interactions with the environment. The events/phenomenon is perceived by humans and captured as data (sign), through an interface for storage in the IS/IT system. Similarly, when data or information (processed data) is retrieved from the IS/IT system, it is used as knowledge to solve a problem, or applied to a situation within the environment. In effect the social environment has a huge effect on what is stored and what is retrieved from IS/IT systems.

Three out of five of the individual cultural dimensions namely collectivism, uncertainty avoidance and long-term orientation were found to significantly mediate the mediate the between context-based object and data quality; context-based data and information quality; and context-based information and knowledge quality. The items for the power distance and masculinity cultural dimensions consistently recorded very low factor loadings, reliability and validity figures and were therefore dropped from all the structural models. It is also possible that power distance and masculinity dimensions were insignificant when people engage in data, information and knowledge activities. For example, power distance relates to equality among people and the role of social norms in power segregation in society and in the workplace (Hofstede 2001), its direct relevance to how individual interact of data, information and knowledge may not be explicit. Similarly, masculinity, which relates to gender equality and assertiveness (House et al. 2004; Hofstede 2001), may not have direct relevance to an individual when he/she interacts with data, information and knowledge. Therefore, dropping the power distance and masculinity dimensions did not affect the measurement of individual culture, as there was more than enough evidence of the measure of individual culture in the other three dimensions used (i.e. collectivism, uncertainty avoidance and long-term orientation).

The results from the four structural models revealed that individual culture represented by collectivism, long-term orientation and uncertainty avoidance) had significant mediation effect of 94.3%; 96.5% and 89.4% respectively on the relationship between context-based object and quality of data; context-based data and quality of information and context-based information and quality of knowledge. This is consistent with studies, which revealed significant relationship between collectivism and knowledge sharing (Bao. et al 2015); and positive effect of uncertainty avoidance on information sharing (Albuloushi & Algharaballi 2014). Thus, different levels of uncertainty avoidance, collectivism and long-term orientation affect data, information, knowledge and knowledge activities. Therefore, individual culture (Hofstede et al. 2010; Yoo et al. 2011) affect how people assimilate information and use it to engage in knowledge activities.

The results for the study showed that individual cultural differences, which may affect their behaviour and capabilities in terms of how they interact with objects in the environment, engage with IS and carry out information and knowledge activities. Not only has the study validated the mediation effect of individual culture on the relationship between context-based object and data, information and knowledge been through the structural models, but also demonstrated the significant role of human/person an information as a component of information systems. These addresses the question as to how individual culture influences affects data storage and information retrieval from computer-based systems (**RQ2**). The next section discusses the HII framework and how it addresses the problem of missing context in data stored in IS.

8.2.3 The HII Framework for IS/IT Systems

The study proposes a HII framework to address the research question (i.e. **RQ3**) "how can incorporates users' pragmatic needs and social context be incorporated into the data, information and knowledge interfaces of computer-based information systems? Drawing on semiotics or the science of signs and meaning, we argue that the current lack of quality of stored data in IS, is due largely to inadequate context because IS interfaces are only capable of representing data/information in one dimension (syntactic). However, if data/information storage can be done at a multi-dimensional level, specifically at a three-dimensional level to include the semantics and pragmatics of data as well, the problem of inadequate context in stored data in IS would be greatly enhanced with significant implications for making technology and IS more intelligent. We therefore propose the concept of human information interface (HII) and human knowledge interface (HKI).

We conceive HII and HKI as interdisciplinary fields of study that focuses on the human information and knowledge dynamics in order to enhance the understanding information and usability of knowledge derived from the information thereof. We define these concepts as follows:

> *HII is defined as the point where a human user makes exact meaning of stored data and information devoid of the user's own knowledge and understanding in order to engage in context informed information activities.*
>
> *HKI is the interface where a human user is able to adopt and adapt information to new situations based on the context of the data stored; and the information retrieved from a system to engage in knowledge activities.*

The data from the studies showed that, the human user feature significantly at each phase and interface of the entire data-information-knowledge spectrum. At the point of data input into IS, is the human-data interface which has been widely promoted within the domain of HCI and user interface design. Whilst several factors may affect the quality of data captured during input into IS, the main problem is how much of context of the phenomenon does current IS interface allows to be stored with the data especially the semantics and the pragmatics of the data? These are certainly issues more dependent on the human user than the IS interface design, at best technology can capture and transform data into information based on human specified rules, procedures and policies (Opoku-Anokye 2014; Liu 2000), but these factors are all tied to the knowledge of the user at the point of retrieval of the data from an IS/IT system. Human issues in the data processing and information retrieval phase is therefore far beyond the scope of HCI, hence the concept of HII.

In addition, at the knowledge level, the role of the human user of information is very critical. Knowledge activities are dependent on the user's understanding of the context of the data and information, in order to be able to engage in knowledge specific activities. The user will be well served by awareness of the context of the data/information stored, and an appreciation of a situation to be able to adopt and adapt the available information as knowledge to this new situation. In effect knowledge activities very much depends on the human user, as technology or IS cannot convert information into knowledge.

8.2.4 The impact of the context-based human information interface framework on knowledge activities

The steps taken to address the research question (i.e. **RQ4**) "does a context-based human information interface framework enhance the usability of information from computer-based systems for knowledge activities?". These include quantitative and qualitative studies to validate the HII framework. The quantitative validation was conducted using a hypothetical scenario which assumes the design of the proposed context-based IS in a survey. The relationship between context-based HII and knowledge activities was tested. The results revealed significant positive relationship between context-based interface and knowledge activities. The HII framework advocates for the design of context-based IS interfaces to enable the capture of more context details that includes not only "what" the event is about but also "when" it happened, "where" it happened, "who" was involved, "how" it happened and the "situation" under which it happened. This will in no doubt reduce the need for the user who retrieves data form IS to add his/her own knowledge to the data to understand and use it for information and knowledge activities. In effect, this offer a better way to perceive objects or events in the environment and overcome the reductionist principle (Gibson

1978; Wang 2018) which underpins how humans currently interface with events, data, or information in the environment and capture it for storage in IS.

The need to design databases that can support the additional context details is equally important as the design of the context-based IS interfaces. The results from the study indicates that current databases and IS features could be configured to capture some of the proposed context details such as "where" the event happens, "who" was involved and "what" happened. It was inferred that with technological developments such as internet of things (IoT) and the use of sensors, already more context details such what (event), where (place), when (time), and the "situation" under which events happens are already being captured and stored in IS. In effect, current dynamic databases store factual data which may have context details of "what", "where", "when", "situation" and "what"; whilst context details particularly "how" the event happened at first and "why" it happened could be the focus of context-based IS and the corresponding database backbone. Current databases were therefore described as "meta-what" and this study prescribed additional layers of database called the "meta-how" and the "meta-why" which is considered as synonymous with the semantic and pragmatic layers of the semiotic framework. The implementation of a context-based IS supported by a multidimensional layer database backbone (i.e. meta-what, meta-how and meta-why) will in no doubt enhance the quality of data stored and retrieved from IS for information and knowledge activities.

It is anticipated that the design and implementation of the proposed context-based IS and multidimensional databases would not be without challenges, as it would require a totally new approach to requirement analysis and design of IS and databases. This notwithstanding, the results from the quantitative and qualitative studies and the case studies respectively demonstrates the validity, applicability and utility of the HII framework. Therefore, the research question (**RQ4**) i.e. "does a context-based human information interface framework enhance the usability of information from computer-based systems for knowledge activities?" was addressed by the results of this study. These results then served, as a basis to ascertain whether context-based IS impact on the quality of knowledge activities.

8.2.5 The impact of context-based IS on quality of knowledge activities

Further quantitative and qualitative studies were conducted to address the research question (**RQ5**) i.e. "to what extent does improved (context-based) data, information and knowledge interfaces impact on the quality of knowledge activities? The relationship between quality IS (defined as context-based data, information and information interfaces) and the quality of knowledge activities as outputs from IS was investigated. The results confirmed the hypothesis that context-based IS would have a significantly positive relationship with quality of knowledge activities (Brazier et al. 2000; Dey 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa 2003, Dzandu & Tang 2015). The role of individual culture and interface factors as mediators were confirmed. However, interface factors accounted for only a minimal proportion of the mediation effect, to re-emphasis the significant role of individuals/person factor as a component of IS (Maier 2012; Tenopir et al. 2011; Brazier et al. 2000). The reason for this could be that the interface factors represent the semiotic dimensions of how the human actor (interpretant) interfaces with the object and represents it as a sign. In effect, even though this study assumed mutual exclusivity of individual culture and interface factors, the results of the study showed the inseparability of individual and his/her semiotic capabilities. This aligns with assumptions that humans are semiotic beings (Peirce 1998).

The additional response from the interviews further confirms the importance of context in achieving quality outputs from IS. The results show it is possible to capture key context details of an “object” (which emanates from the environment) into IS and consistently make these available to users when they retrieve data from IS. This will reduce the need for the users to add their own knowledge to the data in order to understand the context of the data and thereby enhancing the quality of information and knowledge activities undertaken. This would help reduce some of the misconceptions about the quality of knowledge derived from data stored in IS. The design of context-based IS interfaces would also enhance the intelligence of IS/IT systems as more reasoning algorithms can be built to leverage on the available context details (Zainol & Nakata 2010; Zainol & Nakata 2012). The proposed HII framework also fits in with the emergence of IoT, as the source of data could be sensors for which could be programme to capture as much context details from the environment and feeding these into IS. The indications of the results are that quality of outputs from IS depends on the quality of IS interface as well as the availability of context details about the data when it is being stored by individuals and by extension, sensors. The study has therefore demonstrated that improved (context-based) data, information and knowledge interfaces impact on the quality of knowledge activities (i.e. RQ5).

Overall, this research answered the key research questions and achieved the aim of the study. Not only has the results filled a literature gap on context-aware IS for knowledge activities, but it has also demonstrated the need to develop context-based IS interface that captures more context details to guarantee context-specific information and knowledge activities. The study has demonstrated that quality of IS significantly depend on the quality of data, information and knowledge stored and retrieved from the IS, therefore the design and capture of more context details into IS would in no doubt enhance the quality of knowledge activities when users interact with IS.

8.3 Evaluation of the Research Objectives

In Chapter One, the entire PhD thesis was introduced and the research background and motivation for this research outlined. The aim and objectives of the study were thus set out in Chapter 1, and the remaining Chapters 2 – 8 demonstrates how the aim and objectives of the study were achieved using the design science process.

Chapter Two was the review of pertinent literature on sources of context of data or information, IS/IT system interfaces, and how these impact on the quality data, information, and knowledge. The literature was drawn from several disciplines including Information Systems, Information Science, Business Informatics, Computing, Context Aware Systems, HCI, Psychology and Management. From the literature review, the problem the problems of lack of context in stored data and information in IS/IT systems were evident and the sources of the problem were inability of current design of IS/IT systems to capture some context details; human behaviour, and lack of systematic approach to understand the human information interface. The literature reviews thus demonstrated the relevance of the problem whilst partly addressing two main objectives of the study that is 1) determine the sources of missing context and information gaps in stored information in computer-based systems; and 2) ascertain factors that influence data storage and information retrieval from computer-based systems.

In Chapter Three, the methodology and methods on which the entire study was anchored are discussed. How data was collected and analysed and the design process leading to the development of the context-based HII framework were demonstrated. Research philosophies and paradigms within the fields of IS research were discussed and compared to decide on the best and most appropriate to drive this study. Research philosophies and paradigms serve as a guide to judge the relevance, validity, acceptability and replicability of research outputs. This chapter therefore discussed and justified the choice of pragmatism as the research philosophy and design science as the research paradigm. These informed the selection of the appropriate research approach, techniques, methods and process on how data was collected, analysed and presented to address the research aim and objectives.

In order to achieve the objectives of determining the factors that affects data storage and information retrieval and identify the sources of missing context in stored data in IS/IT systems; the mixed methods approach (Venkatesh & Brown 2013) involving qualitative critical analysis of literature and quantitative surveys (Maxwell 2005) as well as the case studies used are discussed. In addition, to address the research objectives on how more context could be built into the data and information interface in IS/IT systems, the surveys and interview methods used were discussed. Furthermore, how the artefact (HII framework) was evaluated for applicability; validity and relevance through mixed methods of critical review or discussion, questionnaire survey, and expert reviews were also discussed. The research methodology thus demonstrates relevance, rigour, and design criteria to produce an IT artefact.

In Chapter Four, a preliminary study accomplished through mixed methods approaches are used to demonstrate the evidence of the problem and the development of the conceptual framework. The outcomes of this study helped to establish empirical evidence of the main research problem whilst addressing two key objectives, that is 1) determine the sources of missing context and information gaps in stored information in computer-based systems; and 2) ascertain how individual culture influence data storage and information retrieval from computer-based systems.

Using the content of an eLearning course as proxy of information system, data collected from participants at the end of an eLearning course in statistics was analysed focusing mainly on the data and information gaps from their interactions with the course content. The findings revealed inadequate capture of context in the content of the eLearning course stored in the leaning management system (LMS). The missing context issues identified included but not limited to culture, non-localised, non-exhaustive information, information dissymmetry, etc.; in a way reflects the pragmatic and social context issues related to the "why", "how" and "situation" of the stored content. These affected understanding or semantics of the stored eLearning content among several actors in the interaction process. A conceptual model was developed out of the preliminary study and this served as a blueprint for addressing two other objectives of the study, that is 3) how can users' pragmatic needs and social context be incorporated into the data, information and knowledge interfaces of computer-based information systems? and 4) does a context-based human information interface framework enhance the usability of information from computer-based systems for knowledge activities?.

In Chapter Five the context-based data interface framework from the previous chapter is refined through further analysis of survey data and interviews to arrive at the a context-based information interface framework. In order to achieve the main aim of investigating how human information interface impact on knowledge activities, this chapter provided answers to the third and fourth objectives of the study, that is, 1) how can the designs of information systems effectively incorporates users' pragmatic needs and social context into the data interface? and 2) how can pragmatic and social context be built into the information interface to enhance the usability of information retrieved from computerised information systems? The concept of human information interface (HII) which till date has not been explicitly defined in IS interactions literature has been presented. The concept of human knowledge interface (HKI) was introduced and defined.

In Chapter Six, the third iteration was carried out in order to develop a mini artefact in the form of context-based knowledge interface (CBKI). First, from interviews responses and evidence from literature, the CBKI artefact was developed by extending the context-based information interface framework to show how users can adapt and apply the available context-based information to different situations. The responses from the interviews showed that in addition to the ability to retrieve those context-details about an object/event, a knowledge interface should allow users to apply and adapt these to make better decisions, gain insights, intelligence and solve problems. The proposed CBKI framework was then validated quantitatively with survey data. Using structural equation modelling, it was revealed that human factors (individual culture) significantly mediate the relationship between context-based knowledge interface and the quality of knowledge. These provided answers to the third and fourth research questions of the study at the pragmatic level. That is how can the designs of information systems effectively incorporates users' pragmatic needs and social context into the knowledge interface? and can pragmatic and social context be built into the information interface to enhance the usability of information retrieved from computerised information systems? The CBKI artefact was then refined leading to the development of the HII framework.

The evaluation of the framework was covered in Chapter Seven. The potential impact of HII framework was verified through a mixed method approach. Using a questionnaire survey, the perceived impact of context-based data and context-based information on the quality of knowledge activities was assessed. Context-based data and context-based information were used as proxies for context-based data interface and context-based information interface respectively whilst knowledge activities were used as proxy for a range of activities such as knowledge sharing, acquisition, transfer, among others. Structural model was used to confirm the significance of the relationship between context-based data and context-based information and knowledge activities. In addition, expert reviews with case studies were used to establish the utility, validity, and acceptability of HII model. Through the expert reviews, suggestions were sought and used to enhance the HII framework. Therefore, not only did the study achieve the fifth objective of evaluating if improved data and information interface design will enhance knowledge activities, but it also fulfilled the evaluation criteria of the design science research process.

In Chapter Eight, the key outcomes of the study were discussed with respect to the research objectives. Evidence of missing context in stored data/information in IS/IT systems from the case studies and interviews were pitched against extant literature. Also, the impact of culture as a function of human actor and the semiotic inspired interfaces factors as moderators which were considered very critical to the design of context-based interfaces for IS/IT systems are discussed. The HII framework was also discussed in relation to its implications for the quality of data, information, and knowledge found in IS/IT systems. The potential impact of designing context-based human information interface to enhance human understanding and usability of stored data/information in IS/IT systems is also discussed.

A summary of the main objectives, with the corresponding findings are show in Table 8.1

Table 8.1: Summary of research objectives, evidence, findings and limitations

Study Objectives	**Evidence**	**Findings/outcome**	**Limitations**
1) what are the sources of missing context and information gaps in stored information in computer-based systems?	Literature (Dey, 2001; Jang & Woo 2003; Abowd & Mynatt 2000; Trillet 2007; Sowa 2003, Dzandu & Tang 2015, etc), and data from survey & interviews	Limited capability of current IS systems, interface factors, culture, human factors; effort, etc.	What about non- IS situations? e.g. Human–human interactions?
2) explore the effects of individual culture on data storage and information in IS/IT systems	Literature (Schmidt 2000; Rosenbloom & Larsen 2003; Dey 2001; Nadee 2016) & data from surveys (case studies)	Individual culture (human factors) and interface factors had significantly impact on storage and retrieval of context-based data and information from IS/IT systems (p<0.05)	How do context issues impact on knowledge activities in non-IS situations
3) how can more context be built into the data and information interface to enhance the quality of knowledge activities?	Literature proposed multi-dimensional approach to data/information storage (passive) & based on based on surveys and interviews	Significant relationship between context-based data interface and information quality (p<0.05). Context-based interface framework	What about dynamic systems – instantaneous changes in context details?
4) to what extent does an improved information interface design impact on the quality of knowledge activity?	based on surveys and interviews with case studies during the validation of the framework	Significant relationship between context-based interfaces and knowledge activities.	What about non-language centric situations?
5) to evaluate the framework to ascertain the extent to which improved data and information interface design impact on knowledge activities	based on survey and interviews from expert reviews with case studies during the evaluation phase of the study	Significant relationships were found between context-based IS interface and knowledge activities (p<0.05).	What about testing such interfaces for acceptability before deployment among different users

8.4 Research Conclusion

This study has presented a framework for designing context-based interfaces with implications for consideration of a new approach to analyse, identify and capture context when data or information is being stored in an IS/IT system. The framework identifies the source of context information as emanating from the environment but due to limitations of current IS/IT systems in capturing all the context details; a reductionist principle (Gibson 1978) underpins by the triadic semiotic principle is used to capture only some part (what) component of context. This create context deficiencies in stored data or information, but the HII framework provides an architecture that supports a design process for building more context into IS/IT systems to enhance not only the understanding and usability of stored information by human users but has the potential of enhancing the meaning making capabilities of machines and individuals.

The research justified the need for building more context into IS interfaces whilst confirming Gibson's (1978) reductionist principles as plausible reason for missing context in stored data in IS. The type of context details to be captured from objects/events in the environment and stored in IS are identified from literature and used to inform the iterative development of context-based interface model, leading to a context-based information interface model then a knowledge-based interface model culminating in the development of the HII framework. The models and framework were developed and empirically validated using questionnaire surveys and interviews.

The HII framework first identifies semiotic inspired interface factors, which together with human factors (specifically individual culture) moderate the effect of context-based data and context-based information on the quality of data, information, knowledge and knowledge activities. Expectations are that consideration of HII as a discipline and exploration of human interface issues, which are beyond the purview of HCI, would have huge impact in this era of the "disappearing computer". The study therefore expanded our understanding of context-based information systems and the limitations of HCI. The use of cases studies by the expert reviewers and the SEM analysis were used to validate the HII framework for potential utility, applicability and validity.

The research investigated the impact of the individuals using the CVScale by Yoo et al. (2011) (i.e. the enhanced Hofstede's cultural dimensions at the individual level) and semiotic inspired interface factors on knowledge activities. The results from the SEM analysis showed that individual factors particularly such as collectivism (CO), long-term orientation (LO) and uncertainty avoidance (UA); and semiotic factors particularly intentions (INT), acquisition (ACQ) and usability (USA) have high mediation effect on the quality of data, information and knowledge stored and retrieved from IS for knowledge activities. This research therefor highlights the significance of the individual and semiotic processes in human interface and interaction with information and IS.

8.5 Research Contributions

This section explains in detail the theoretical, methodological and practical contributions of the study. The thesis provides significant contribution to existing literature on human computer interaction by proposing the human information interface; and the development of context-based based IS interfaces. The mediating roles of the individual (user) and interface factors during the storage of data and retrieval of information from IS for knowledge activities are highlighted.

8.5.1 Theoretical Contributions

This study makes unique contributions to information systems design theories, whilst expanding scholarship on human information interaction. The reviews and analyses of the impact of culture on human information interaction offer possible empirical evidence on how culture impact on information systems and contribute to the debate on why information systems fail, how to design flexible information systems, especially global information systems as in the case of multinational companies. This study also contributes to the advances in the field of human computer interface (HCI) and makes a case for a paradigm shift from HCI to human information interface (HII), a relatively new but emerging discipline with a focus on how humans interface with information in the era of pervasive yet disappearing computers.

The study also makes contribution in the area of socio-technical approach to information systems. The human information interface framework contributes to theoretical underpinnings of the data, information, and knowledge evolution and their implications for the quality of information and knowledge activities, knowledge management systems, decision making, intelligence derived from stored data or information in IS/IT systems.

8.5.2 Practical Contributions

This study contributes an artefact in the form of a human-information interface (HII) framework that can serve as a guide in the design of improved data and information interfaces that incorporates more contexts into data and information stored in computerised information systems. The outcome of the evaluation demonstrated the potential of the artefact in making information found in IS/IT systems more adaptable to user's pragmatic requirements and social context. Given the seemingly lack of framework for information systems design that reflects users' cultural orientation, intentions and usability requirements, the HII framework offers one solution.

The HII framework clearly offers a potential solution to address the current challenge of missing context in stored data and information in information systems (IS). The processes leading to the design of the multimodal data and information interfaces for IS/IT systems will not only make the interfaces and enhance their usability but should help provide more contexts and enhance the quality of knowledge activities based on stored data/information. The HII framework thus hold enormous potential for improving the capabilities of AI, and the intelligence of expert systems; machine learning, data analytics and computerised information systems by providing more context.

The study contributes a potential resolution to the current challenge of adequately capturing the context of data at the syntactic level to improve the semantic and pragmatic capabilities of stored data in IS/IT systems. The proposed multidimensional databases to help store the semantics and the pragmatics of data at the human interface with IS/IT systems offers enormous opportunities for improving database design, data storage and information retrieval in this era of big data and information overload. The need to expand the scope of requirement analysis in the design of databases to support IS/IT systems is also emphasised. In addition, the potential to develop a semiotic-inspired metrics based on the interface factors for assessing the quality of human information interaction, data, information, knowledge quality as well as the quality of knowledge activities have been demonstrated.

Another practical contribution of the study is the understanding of the impact of individual culture on data, information and knowledge activities. Information management and human resource practitioners would find the results useful especially for personnel management. The adapted cultural scale can be used to assess and establish the competencies and capabilities of data or information management personnel during interviews and on the job to find the best-fit job schedules based on their cultural disposition.

8.5.3 Methodological Contributions

The main methodological contribution is the argument for the need to approach the design of interfaces from not only the technical orientation, which has been the preoccupation of HCI; but to consider the human orientation such as culture in the proposed HII discipline. Adapting Hofstede's individual cultural dimensions to information systems research provides new perspectives to how the social-environment layer, which has often been ignored in semiotics studies in IS can be applied. Whilst the semiotic layers include social-environment, most researchers have focused on the syntactic and semantic layers, with less consideration for the pragmatic and the social-environment dimensions. This study seeks to demonstrate that, methodologically, the social-environment can be operationalised and modelled to ascertain the extent to which it affects information and knowledge activities (semantics and pragmatics).

Another methodological contribution is the systematic approach to identifying the components of context using evidence from context-aware literature together with Zachman's (1987) framework for enterprise information system architecture.

The summary of the contributions of this thesis are:

1. clarification of the ambiguity surrounding the approach to the design of context-based interface in IS/IT systems to enhance human understanding and usability of data/information retrieved from systems
2. the refining and defining of the concept of HII as a discipline that explores the human-information space whilst identifying a novel concept of HKI within knowledge management literature
3. the development of a context-based human information interface which can support requirement analysis for information systems design
4. the development of a framework which has implications for architectural requirements for designing context-based interfaces for IS/IT systems to enhance understanding
5. the exploration of the design of multi-dimensional databases to support the capture of more context details when data/information is being stored in IS/IT systems.

8.6 Implications of the Results

The results of the study have several potential implications for theory and practice. It has theoretical implications for communication theory in general; and specifically, human-machine communication. Given the importance of context in understanding communication between entities, perhaps a redefinition to reflect the role of context in achieving understanding during the communication process is not far from consideration.

The HII framework also has implications for practice in terms of database design, meta-data description and programming of information systems. It provokes to need to expand the scope of requirement analysis to support the representation and retrieval of data and information at a multidimensional level which allows more context to be built into the interfaces of IS/IT systems. Consequently, issue of data redundancies and optimisation of storage space and speed of data access from the proposed "context store" would need different and new approaches.

The implication of this study for machine learning and deep learning are worth noting. Given that machine and deep learning are all data and information communication and processing just like humans do, a very critical component for achieving meaning is context, beyond what is currently achievable with IS/IT systems. The consideration of the "meta-how" and "meta-why" offers potential solution to making machines more intelligence or meaning making. The potential implications of this study are that expert systems, artificial intelligence and robotics could benefit from context-based interfaces and systems that enhances sense making, understanding and usability of stored data or information.

The HII framework also has implications for enhancing design of context-aware systems and pervasive computing systems. Current context aware systems and pervasive computing focuses attention on some context components such as "what" is happening "where", "when", the "situation" under which the event is happening and "where" or location of the event. There is still very little or no context details on "how" and "why" the event happens in current context-aware and ubiquitous computing systems. Therefore, the proposed "meta-how" and "meta-why" in addition to the current "meta-what" would in no doubt have implication for enhancing the intelligence of context-aware and ubiquitous computing systems.

The proposed HII framework also has implications for designing IS for businesses, co-design of IS and context-store, data analytics and big data for the purposes of making context-specific decisions, information modelling and developing information architecture. However, the several implications enumerated in this section were not the focus of the study. The next section outlines the limitations and future research directions based on the outcomes of this study.

8.7 Limitations and Future Research Directions

Research work usually have limitations and this study is no exception. As it was not possible to test the actual framework in a real setting during the life of this research, the case studies were only proof of concepts. It would be worth designing an IS/IT system interface which will test the framework in a business setting and provide empirical proof of the efficacy of the HII framework.

Furthermore, the framework may not apply to all situations for IS/IT system design. This is because the purpose of use of the system owner may not require the need for the proposed context details to be captured when the data or the information is being stored in the IS/IT system. Therefore, the framework cannot be generalised to all IS/IT situations, or where necessary generalisation must be done with caution. Although the relevance, validity, and applicability of the HII framework was confirmed with case studies from banking, business, and security sectors, it would be worth assessing the framework in other economic sectors and in different geographical locations or cultures.

In addition, given that the framework was designed with reference to IS/IT systems (human-machine situation) there is not much evidence to suggest applicability of the HII framework in human-human interactions. Efforts in this direction would be worth considering in order to assess how context details and perceptible semiotic interface factors impact on communication in a human-human situation.

It appears capturing the “how” and “why” of data or an event would be a very challenging task. Therefore, future research could first explore the possibility of integrating the proposed “meta-how” and “meta-why” into the existing meta-what (meta-data) of databases in the design of context-based interfaces for an IS/IT system. In addition, the acceptance of context-based interfaces by users (clients and employees) would need to be tested before any such systems are deployed especially in organisations. This research thus provides opportunities for future studies on technology adoption to explore the application of technology acceptance models to potential context-based IS within different environment or cultures.

There are also opportunities to extend this study in the future to consider capability and competence as proxies for human factor instead of individual culture. It would be interesting to see other human factors such as personality and even personal characteristics of people impact on data storage and information retrieval for knowledge activities.

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Appendix 1a –Consent Form

Henley Business School

Research Ethics Committee

Consent Form

1. I consent to take part in this study by Michael Dzandu. The accompanying Information Sheet relating to the project on: "**Towards a human information interface framework for knowledge activities"** has been explained to me.

2. I can confirm that the purpose of the project has been explained to me; and what will be required of me, and any questions I had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet so far as they relate to my participation.

3. I understand that participation is entirely voluntary and that I have the right to withdraw from the project at any time, and that this will be without detriment.

4. I understand that this research has been reviewed by the School Research Ethics Committee and has been given a favourable ethical opinion for conduct.

5. I have received a copy of this Consent Form and of the accompanying Information Sheet.

Name: …………………………………………………………………………………

Signed: …………………………………………...………………………………

Date: ……………………………………………………...………………………

Appendix 1b – Information Sheet guidelines

Henley Business School

Research Ethics Committee

Dear Participant,

INFORMATION SHEET

I am a doctoral researcher in Business Informatics at the Informatics Research Centre/Business Informatics, Systems and Accounting, University of Reading, United Kingdom. I am conducting a research that seeks to develop a framework on human information interface for knowledge activities.

The outcome of this research is a framework to understand why current IT systems are limited in representation of data with regard to context and; how these affect the quality of information and knowledge activities based on the stored data. The result of the study would have practical implications for interface design and the way data is stored in, and retrieved from IT systems, development of artificial intelligent systems, robotics, Internet of Things (IoT) and those other systems that rely on stored data.

Please, note that your participation is entirely voluntary, and you can exercise your right to withdraw from the study at any time if you so wish. Also, be assured that the information provided will be treated confidentially and securely disposed after the research. This research has been reviewed for ethical appropriateness by the Ethics and Research Committee of the school. After completion, you can access the research results upon request. Please, do not hesitate to contact me by email if you have queries, or seek clarifications at m.d.dzandu@pgr.reading.ac.uk.

Thank you.

Michael Dzandu

(Doctoral Researcher)
Business Informatics, Systems and Accounting
Henley Business School
University of Reading
United Kingdom

Appendix 1c

Brief Summary of the Project and Research Methods

This study questions the quality of knowledge derived from stored data and/or information in information technology systems (IT) given that currently IT systems are only capable of syntactic representation of data. This situation results in missing context when users retrieve stored data from IT systems for information and knowledge activities.

When people interact with data/information, they have had to rely on their imagination to add meaning to the stored data causing wide semantic and pragmatic gaps.

The question that arises includes where, how, and why does data loose its semantic and pragmatic characteristics; and how does this affect the quality of information and knowledge activities? What could constitute a human information interface that would help people to make better meaning when they interact with information in IT systems?

This project thus aims to develop a human information interface framework that could help reduce context deficiencies in stored data/information whilst helping to improve the quality of information and knowledge activities undertaken by people based on the stored data.

The design science approached is used and multiple sources of data including case studies, questionnaire survey, experiment and interviews are relied upon to develop and validate a human information interface framework.

Appendix 2: Questionnaire for assessing the influence of culture on human information interaction on computer-based information system.

Informatics Research Centre/Business Informatics, Systems and Accounting
Henley Business School
University of Reading, UK

Human information interaction in computer-based information system

Dear Respondent,

I am a PhD a student; and as part of my research, I am conducting a preliminary survey to understand the influence of culture on human information interaction (HII). This questionnaire is meant to assess how you interact with information in computer-based information systems (databases, online catalogue, computerised information systems, electronic information systems, etc.). Kindly answer the following questions by placing a tick against the questions rank or stating your responses. You are assured of the strictest confidentiality and anonymity.

Thank you

Michael Dzandu
(PhD Research Student)

Section A: Context of the Study

1. How often do you use computer-based information system?
   i) Dailyii) 1-2 days a week iii) 3-4 days a week iv) 5-7 days a week v) Other (please state)……………………………… x) Never
2. Which of the following activities do you do most on computer-based information system?
   i) Create new information ii) Store information iii) retrieve information
   iv) share information v) archive information vi) transfer information
3. What is the first thing that come to mind anytime you access information from computer-based information system (just state, do not think too hard)?
   ____
   ____
4. To what extent do you feel that the information you retrieve from computer-based systems match with your intentions of use of the information?
   i) Do not match at all ii) Do not match iii) Match to a moderate extent
   iv) Match to some extent v) Match to a considerable extent

4b. Briefly explain the basis of your answer in q4?________________________________
____

Section B: Interactions with information in computer-based systems

Please tick one box for each statement according to how you disagree or agree with the statement with respect to your interactions with information in computer-based systems (databases, online catalogues, students records management systems like RISISweb Portal, course information systems like Blackboard, etc.), using this key***:***

1 = STRONGLY DISAGREE, 2 = DISAGREE, 3=NEUTRAL, 4 = AGREE, 5 = STRONGLY AGREE

Intentions		1	2	3	4	5
i.	I consider the purpose for which I want to use information now anytime I access information from computer-based systems.					
ii.	I consider the purpose for which I may use particular information in the future anytime I access information from computer-based systems.					
iii.	I consider my past intentions of use of information in anytime I try to access information from computer-based systems.					
iv.	I consider how I can adopt information to my task or to meet the purpose for which I access information from computer systems. (Intention)					
v.	I would be able to use information from computer-based systems more if my intentions can be stored with it. (Intention)					
Acquisition						
i.	I consider my level of skill when I interact with computer-based information system.					
ii.	I consider my knowledge when interacting with information.					
iii.	Training is always important before I interact with information in computer-based systems.					
iv.	I always consider the range of additional information needed when I interact with information in computer-based systems.					
v.	The process of acquiring information is very important to me.					
Usability (Utility)						
i.	I always act in ways that make for easy use of the information I retrieve from computer-based information systems.					
ii.	I always consider how well information will improve my work or enhance the purpose of use.					
iii.	I consider the relevance of information to my intentions or purpose of use.					
iv.	Accessibility is very important to me anytime I try to use information from computer-based systems.					
v.	I am very concerned about how information presentation is related to usage.					
Semantics						
vi.	I always have to add my own meaning to information I retrieve from computer-based systems in order to understand it. (Semantic)					
vii.	I always compare my previous experiences in achieving a balance between the information I retrieve from computer-based systems and what I can use such information for. (Semantic)					

viii.	I am able to match the information retrieved from computer-based systems with the initial intention with which the information was created. (Semantic)					
ix.	Social world					
x.	I will need information from computer-based systems to have more contexts to enhance my understanding. (Social E)					

Section C: Cultural Orientation

Consider information that has been stored in a computer-based system (databases, online catalogues, students' record management systems like RISISweb Portal, course information systems like Blackboard, etc). In retrieving information from any of such computer-based systems for academic work and with respect to your interactions with the information, ***rate the extent to which you disagree or agree with the statements using this key:***
1 = STRONGLY DISAGREE, 2 = DISAGREE, 3=NEUTRAL, 4 = AGREE, 5 = STRONGLY AGREE

Power distance	1	2	3	4	5
1) People in higher positions should make most decisions without consulting people in lower positions.					
2) People in higher positions should not ask the opinions of people in lower positions too frequently.					
3) People in higher positions should avoid social interaction with people in lower positions.					
4) People in lower positions should not disagree with decisions by people in higher positions.					
5) People in higher positions should not delegate important tasks to people in lower positions.					
Uncertainty avoidance					
1) It is important to always have instructions spelled out in detail so that I know what I'm expected to do.					
2) It is important to closely follow instructions and procedures.					
3) Rules and regulations are important because they inform me of what is expected of me.					
4) Standardised work procedures are helpful.					
5) Instructions for operations are very important.					
Collectivism					
1) Individuals should sacrifice self-interest for the group.					
2) Individuals should stick with the group even through difficulties.					
3) Group welfare is more important than individual rewards.					
4) Group success is more important than individual success.					
5) Individuals should only pursue their goals after considering the welfare of the group.					
6) Group loyalty should be encouraged even if individual goals suffer.					
Long-term orientation					
1) Careful management of money (thrift).					
2) Going on resolutely in spite of opposition (persistence).					
3) Personal steadiness and stability.					
4) Long-term planning.					
5) Giving up today's fun for success in the future.					

6) Working hard for success in the future.					
Masculinity					
1) It is more important for men to have a professional career than it is for women.					
2) Men usually solve problems with logical analysis; women usually solve problems with intuition.					
3) Solving difficult problems usually requires an active, forcible approach, which is typical of men.					
4) There are some jobs that a man can always do better than a woman.					

Section D: Personal characteristics

i) Gender: a) Male [ ] b) Female [ ]
ii) Age (years): a) <20 b) 20 – 29 c) 30 – 39 d) 40 – 49 e) 50 – 59 f) 60+
iii) Country of current residence: a) UK b) Ghana c) China d) Other (state)______
iv) Ethnic origin: a) White b) Black African c) Chinese d) Other (state)________________
v) Highest educational qualification: a) Diploma b) BA/BSc c) MA /MSc (d) MPHIL/MBA e) EMBA f) PhD g) DBA

Thank you.

m.d.dzandu@pgr.reading.ac.uk

Appendix 3: Questionnaire for assessing the information interaction processes of participants on an eLearning course

1. Was this your first online computer-based course?

○ Yes ○ No ◉ No answer

2. To what extent did the training fulfil your learning objectives? (1 = not at all, 5 = completely)

1	2	3	4	5
○	○	○	○	○

3. To what extent did the assignments help you to understand the ideas introduced in the teaching sessions? (1 = not at all; 5=a lot)

1	2	3	4	5
○	○	○	○	◉

4. How easy or difficult did you find the course?

Too Easy	Quite Easy	About Right	Quite Hard	Too Hard
◉	○	○	○	○

5. How useful did you find the discussion forums? (if you did not use them, choose N/A)

Not at all	A bit	Quite useful	Very useful	The most useful resource on the course	N/A
○	○	○	○	○	◉

6. How would you rate the Course team (facilitators, experts, managers) on the following aspects?

	Very Poor	Poor	Average	Good	Excellent
Their effectiveness in encouraging participation	○	○	○	○	○
Their effectiveness in answering participants' questions	○	○	○	○	○
Their effectiveness in helping you to apply the topic content	○	○	○	○	○

7. Do you have any comments regarding the course? Anything you particularly liked or disliked? Please be as specific as you can.

8. What skill(s) and or knowledge that you gained during this course will be the most useful to you in your work and future plans?

Appendix 4: Questionnaire for the validation and evaluation of the model

Informatics Research Centre/Business Informatics, Systems and Accounting
Henley Business School
University of Reading, UK

Human information interaction with computer-based information system

Dear Respondent,
I am PhD a student; and as part of my doctoral research, I am conducting a survey to understand the influence of culture on human information interaction (HII). This questionnaire is meant to assess how you interact with information in computer-based information systems (databases, online catalogues, personal information systems, etc.). You are assured of the strictest confidentiality and anonymity. If you would like to take part in the study, give your consent by ticking this box [ ].

Thank you
Michael Dzandu
(Doctoral Researcher)

Section A: Context of the Study

1. How often do you use computer-based information system?
   i) Daily ii) 1-2 days a week iii) 3-4 days a week iv) 5-6 days a week
   v) Weekly vi) Monthly vii) Quarterly

Section B: Human Information Interaction

Please tick one box for each statement according to how you disagree or agree with the statement with respect to your interactions with information in computer-based systems, information/technology systems (IS/IT systems), using the following keys***:***
1 = Strongly Disagree, 2 = Somewhat Disagree, 3= Disagree, 4 = Neutral, 5- Somewhat agree, 6- Agree, 7 = Strongly agree

Information I obtain from IS/IT systems is usually:	1	2	3	4	5	6	7
1) ….in the right quantity.							
2) ….organised in a systematic manner.							
3) ….organised to conform to certain rules (e.g. meta-data).							
When I use IS/IT systems,							
1) …I am able to indirectly interact with the content of the information							
2) …it provides me with interactive format of the information object (e.g. text, image, etc.).							
3) …I am able to create a number of links (mappings) with the information.							
When I access information in IS/IT systems, I am able to:							
1) …perform several actions on the information (e.g. create, evaluate, use, etc.).							
2) …use several media to interact with the information content.							
3) …interact with the content of the information in different ways.							
I am able to interpret information I obtain from IS/IT systems:							
1) .to real-world phenomenon in a way that meets my expectations.							
2) .to real-world phenomenon in a way that meets reasonable expectations.							
3) .to real-world phenomenon in a way that meets well-established expectations.							
I am able to map information I obtain from IS/IT systems:							
1) to at least one real-world phenomenon within the context of what I do.							
2) to at least one real-world phenomenon outside the context of what I do.							
3) to a real-world phenomenon and get the same meaning as when I map the real-world phenomenon back to the information.							

When I use IS/IT systems for information processes, I:							
1) … am able to communicate my intentions to fit my purpose of use.							
2) …always have a purpose for which I want to use the information.							
3) … am motivated to do so because it helps me to achieve a purpose.							
When acquiring information from IS/IT systems,							
1) ….I always consider the range of additional information I need to add.							
2) …the process of obtaining the information is very important to me.							
3) …it is important for me to have skills and knowledge to be able do so.							
Information I obtain from IS/IT systems should:							
1) …..improve the quality of my work.							
2) ….be relevant to the purpose for which I want to use it.							
3) ….be presented in a way that allows me to use it for my intended purpose.							
Based on my experience, I am able to apply information from IS/IT systems to:							
1) ……different tasks.							
2) ……different work situations.							
3) ……a particular context or environment.							
I always ensure that the output consequences of information I obtain from IS/IT systems matches:							
1) ……partly with the initial intention for which the information was created.							
2) ……with the expected impact of the information.							
3) …...with my expected impact.							

Section C: Cultural Orientation – Storing data in IS/IT systems

Consider how you use information system (IS) (e.g. databases, online catalogues, etc.) and/or information technology systems (IT) (e.g. laptops, mobile phones, tablets, PC, etc) to store data; and ***rate the extent to which you disagree or agree with the statements using the following key:***
1 = Strongly Disagree, 2 = Somewhat Disagree, 3= Disagree, 4 = Neutral, 5- Somewhat agree, 6- Agree, 7 = Strongly agree

When it comes to storing data in a system, people in:	1	2	3	4	5	6	7
1) higher positions (authority) should make most decisions without consulting people in lower positions (authority).							
2) higher positions should not ask the opinions of people in lower positions too frequently.							
3) higher positions should avoid interaction with people in lower positions.							
4) lower positions should not disagree with decisions by people in higher positions.							
5) higher positions should not delegate important data storage tasks to people in lower positions.							
When storing data in an IS/IT systems, it is important:							
1) ..to have instructions spelled out in details so that I always know the data I am expected to store.							
2) ..to closely follow instructions and procedures.							
3) ..to have rules and regulations to know what data I am expected to store.							
4) ..and helpful to have standardized procedures for storing data.							
5) ..to always have instructions for storing the data.							
I usually store data:							
1) ..in the interest of a group I belong to (colleagues, friends, etc.) even if it means sacrificing my self-interest							
2) ..in the interest of a group even in difficult situations.							
3) ..in the interest of group welfare other than for individual reward.							
4) ..for the success of a group (or others) other than for individual success.							

5) ..in pursuit of group welfare at the expense of my personal goals.							
6) ..in the interest of and for group loyalty even if my personal goals suffer.							
Long-term orientation towards data storage							
1) I carefully manage data storage processes for future benefit.							
2) I go on resolutely to store data in spite of opposition (persistence).							
3) I usually consider long-term plans and future needs when storing data.							
4) I uphold my personal steadiness and stability when storing data in a system.							
5) I would usually give up today's fun and store data so that I can use it for success in the future.							
6) I usually work hard to store data so that I can use it for success in the future.							
Gender orientation towards data storage							
1) It is more important for men to store data than it is for women.							
2) Men usually store data with logical analytical approach, whilst women usually do so with intuition.							
3) Storing problematic data usually requires an active, forcible approach, which is typical of men.							
4) There are some data storage tasks that a man can always do better than a woman.							

Section D: Context and quality characteristics of data and information

Rate the following context-based and quality characteristics of data and information on a scale of 1-7, where: ***1 = Strongly Disagree, 2 = Somewhat Disagree, 3= Disagree, 4 = Neutral, 5- Somewhat agree, 6- Agree, 7 = Strongly agree***

When data is stored in an IS/IT systems it is important to include details on:	1	2	3	4	5	6	7
1) …the identity of the person who created the data.							
2) …the identity of the object that is being captured.							
3) ….the location of the data (where data was created).							
4) ….the time the data was stored.							
5) ….why the data was created (intention).							
6) ….gestures or signs on how the data was created.							
Data stored in IS/IT system should:	1	2	3	4	5	6	7
1) ….include all the necessary values about the object/person it represents.							
2) ….be accurate enough and fit for purpose.							
3) ….be a proper representation of what it was meant to represent.							
4) ….be well defined and meaningful to others.							
Information retrieved from IS/IT systems should be:							
1) ..interpretable by users							
2) ..useful to users.							
3) ..understandable to users.							
4) ..add value to what users already know.							
When information is retrieved from IS/IT systems it is important to have details:	1	2	3	4	5	6	7
1) on the identity of the person who created the data used in generating the information.							
2) about the data that was used to create the information.							

3) about the location of the data which was used to create the information (where data was created).							
4) about the time when the data was used to create the information.							
5) about why the data was used to create the information (intention).							
6) about gestures or signs on how the data was used to create the information.							

Appendix 4: Questionnaire for the validation and evaluation of the model

Section E: Cultural Orientation – Information Retrieval

Consider how you use information system (IS) (e.g. databases, online catalogues, etc.) and/or information technology systems (IT) (e.g. laptops, mobile phones, tablets, PC, etc) to retrieve information; and rate the extent to which you disagree or agree with the statements using this key:

1 = Strongly Disagree, 2 = Somewhat Disagree, 3= Disagree, 4 = Neutral, 5- Somewhat agree, 6- Agree, 7 = Strongly agree

When it comes to retrieving information from IS/IT systems, people in:	1	2	3	4	5	6	7
1) higher positions (authority) should make most decisions without consulting people in lower positions (authority).							
2) higher positions should not ask the opinions of people in lower positions too frequently.							
3) higher positions should avoid interaction with people in lower positions.							
4) lower positions should not disagree with decisions by people in higher positions.							
5) higher positions should not delegate important information retrieval tasks to people in lower positions.							
When retrieving information from IS/IT systems, it is important:							
1) to always have instructions spelled out in details so that I know the information I am expected to retrieve.							
2) to closely follow instructions and procedures.							
3) to have rules and regulations to know the information I am expected to retrieve.							
4) and helpful to have standardized procedures for retrieving information.							
5) to always have instructions for retrieving information.							
I would usually:							
1) sacrifice my self-interest and retrieve information in the interest of a group I belong to (colleagues, friends, etc.).							
2) stick to a group and retrieve information in the interest of the group even in difficult situations.							
3) retrieve information in the interest of group welfare other than for individual reward.							
4) I usually retrieve information for the success of a group other than for individual success.							
5) only retrieve information in pursuit of their personal goals after considering the welfare of the group they belong to.							
6) only pursue group loyalty and retrieve information in the interest of the group even if my personal goals suffer.							
Long-term orientation towards information retrieval							
1) I carefully manage information retrieval processes for future benefit.							
2) I go on resolutely to retrieve information in spite of opposition (persistence).							
3) I usually consider long-term plans and future needs when retrieving information.							
4) I uphold my personal steadiness and stability when retrieving information from a system.							
5) I would usually give up today's fun to retrieve information so that I can use it for success in the future.							
6) I usually work hard to retrieve information so that I can use such information for success in the future.							
Gender orientation towards information retrieval							
1) It is more important for men to store data than it is for women.							

2) Men usually store data with logical analytical approach, whilst women usually do so with intuition.							
3) Retrieving problematic information from IS/IT systems requires an active, forcible approach, which is typical of men.							
4) There are some information retrieval tasks that a man can always do better than a woman.							

Section F: Quality of knowledge and knowledge activities

Rate the following quality characteristics of knowledge and knowledge activities on a scale of 1-7, where: ***1 = Strongly Disagree, 2 = Somewhat Disagree, 3= Disagree, 4 = Neutral, 5- Somewhat agree, 6- Agree, 7 = Strongly agree***

Knowledge derived from information stored in IS/IT systems should:							
1) …be adaptable to different situations or context.							
2) …be applicable to different situations or context.							
3) …be expandable.							
4) … be true.							
5) … allow for innovation.							
6) … be justified or acceptable to users.							
From the information I retrieve from IS/IT systems, I am able to							
1) acquire accurate knowledge.							
2) generate and share relevant knowledge with others.							
3) completely store the knowledge I obtain for future use.							
4) easily express the knowledge I gain for others to understand.							
5) reliably re-use the knowledge I obtain in new context.							
6) use the knowledge I obtain to stimulate new ideas and add value to a situation.							
7) use the knowledge I obtain to identify new knowledge and apply it to new situations.							
8) use the knowledge I obtain to accurately leverage new opportunities.							

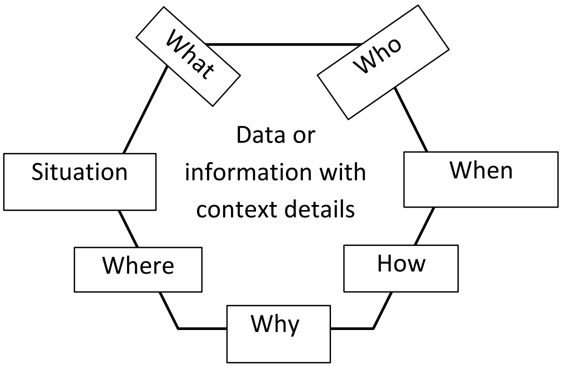
Section G: Demographics

i) Gender: a) Male [ ] b) Female [ ]
ii) Age (years): a) <20 b) 20 – 29 c) 30 – 39 d) 40 – 49 e) 50 – 59 f) 60+
iii) Country of current residence: a) UK b) Ghana c) China d) Other (state)
iv) Ethnic origin: a) White b) African c) Chinese d) Other (state)
v) Highest educational qualification: a) Diploma b) BA/BSc c) MA /MSc (d) MPHIL/MBA/EMBA e) PhD f) DBA
vi) Occupation: a) Teaching b) Banker c) Marketer d) other (specify)…………………
vii) Position (for those working):
viii) Length of service (years):
ix) Industry you work in: a) Education b) IT c) Health d) Banking/Finance e) Public service f) Charity g) Other (specify)……………………………………

Thank you. m.d.dzandu@pgr.reading.ac.uk

Appendix 5: Sample semi-structured interview protocol for experts and reviewers

Interview protocol – Towards context-based interfaces for information and knowledge activities



For the purpose of this study, context details refers to "when", "how", "where", "who" was involved or observed the "situation" under which an event ("what") happened; and also "why" it happened. An event, object or person in this case is the "data".

1. Are current interfaces of IS/IT systems intelligent? If not, why and how does this affect the quality of data and information we capture and store in IS/IT systems*.

   * several other follow up questions emerged during the interview

2. In your view, do you think meta-data associated with current design of database tables serves the purpose of context information about the data/information stored in databases? Can meta-data provide you with all the context details about a particular data/information in terms of the "why" and "how" about the data/information to help you understand it?*

   * several other follow up questions emerged during the interview

3. Is it possible to capture more details such as "why" and "how" about data or information when it is being stored in IS/IT systems? If yes, how - how do we capture the "who", "how", "when", "where", "situation" and "why" about data or an event into an IS/IT system?

Context details	How to capture these (you can use examples to demonstrate)
who	
when	
where	
situation	

how	
why	

4. What do you see as the technical challenges of designing context-based data and context-based information interfaces into IS/IT systems? *

   * several other follow up questions emerged during the interview

5. What do you think are the prospects of building more context into the data and information interfaces of IS/IT systems? How do you see the potential benefits of such systems to data science, data/business analytics, intelligent systems, AI, etc? *
   * several other follow up questions emerged during the interview
6. Any comments/suggestions

No	**Location**	**Company**	**Current Position**	**Cumulative Years of Experience**	**Education**	**Industry**	**Role in the study**
							Expert opinion/ reviewer

Appendix 6: Profile of interviewees and expert reviewers for the study

No	Location	Company	Current Position	Cumulative Years of Experience	Highest Education qualification	Industry	Role in the study
#1	UK	University	Professor of Applied Statistics – Content Developer	30 years	PhD	Education & Consultancy	Main study
#2	UK	University	Professor of Statistics & Tester of E-learning course	18 years	PhD	Education & Consultancy	Main study
#3	UK	University	E-learning content developer	5years	BSc	Education & Consultancy	Main study
#4	UK	University	E-learning Facilitator	3years	MSc	Education	Main study
#5	UK	Worldwide container shipping company	Change Management and DPO	8 years	Degree -	Integrated transport and logistics	Main study
#6	UK	Consulting	(BI Analytics Consultant, Consulting, UK).	15 years	PhD	IT	Main study and expert reviewer
#7	UK/Chile	Software Development	Software Engineer	6 years	MSc	IT	Main study and expert reviewer
#8	UAE/UK	Government Security Agency	Head of Security Information Analysis Dept.	19 years	MSc	Security	Main study and expert reviewer
#9	Ghana	Pan-African Bank	MIS Manager	6 years	MBA/MIS	Banking	Main study
#10	Ghana	Pan-African Mobile Telecom Company	Business Intelligence Manager	12 years	MBA/MIS	Telecoms	Main study
#11	Ghana	Pan-African Mobile Telecom Company	Database Manager	6 years	BSc	Telecoms	Main study
#12	Ghana	Financial Market	IT Manager	16 years	MBA/MIS	Finance	Main study and expert reviewer
#13	UK	NHS	Manager	17 years	MSc	Healthcare	Main study

#14	UK	Data Solutions	Research Analyst	4.5 years	MSc BIM	IT	Main study and expert reviewer
#15	*UK*	International Automobile company	Data Scientist, International Company	6 years	Degree	IT - Data Solutions	Main study
#16	Ghana	University	Lecturer – Computing/IT	9 years	PhD	Education & IT	Main study
#17	UK/Iran	NHS	Research Scientist	7 years	MSc	Research & Education	Main study and expert reviewer
#18	Ghana	International NGO	IT Manager	15 years	MBA-MIS	NGO	Main study
#19	UK	University	Assistant Lecturer	3 years	MPhil - MIS	Education	Main study
#20	UK	Automobile company	Quality Assurance Manager	7 years	MSc	Automotive	Main study
#21	UK	University	Lecturer - Accounting	4 years	MSc Accounting and Finance	Education	Main study
#22	UK	Global Software Company	Solutions Architect	18 years	MSc	IT	Main study

Appendix 7: Evaluation template for the HII framework

Q1. Is this framework valid? If "yes" how is it valid or what makes it valid?
Q2. Is it applicable to your work? If yes, kindly use an example of a scenario to illustrate.
Q3. Are there limitations of this framework, any suggestions for improvement?

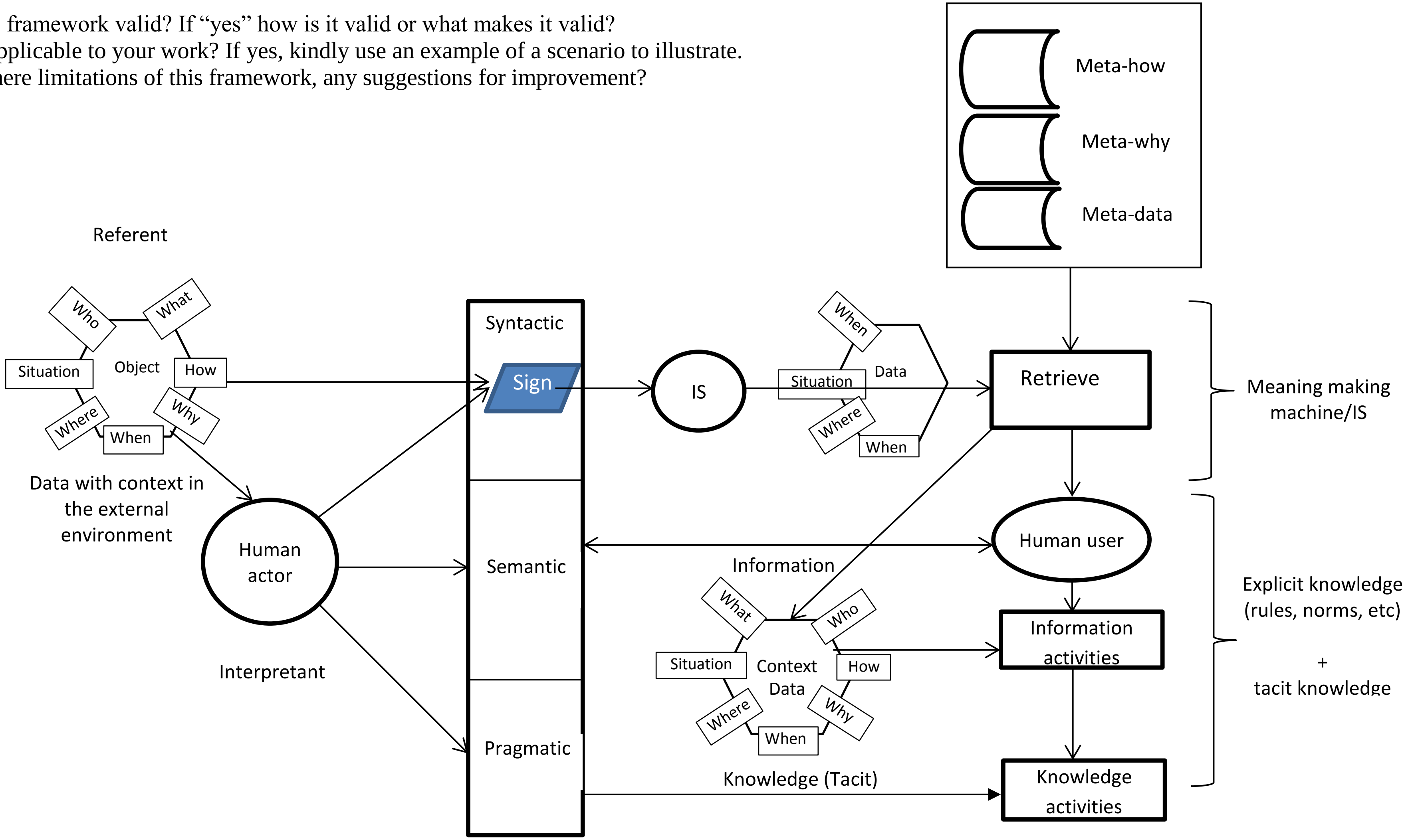


Fig. 5.6: Context-based HII Framework for Information and knowledge Activities