Development of a Holistic Information Systems Artefact to support Pre-experience Undergraduate Education

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Doctorate in Business Administration

Marketing and Reputation

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Declaration

I confirm that this research contribution is based on my own work, and that all externally sourced material has been properly and fully acknowledged.

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Stephen R Gulliver

Acknowledgements

When I completed my PhD in 2004, I studied full-time with limited interruption and/or distraction. This DBA was studied part-time, whilst balancing a full-time career, multiple personal and family dependencies, and the impact of a global pandemic. As a result of undertaking this DBA, however, I have done considerable reading, which I hope has made me a better researcher, supervisor, and person. Saying this I don’t think I’ll be doing it again… well not for a while anyhow!

- To my family – not that you’ll ever read this - Claire / William / Charlotte / Carry - sluts! Thank you for your ongoing patience. You’re the reason I get up every morning – well you and needing the loo. Without you and family I’d have a lot more time, and a lot less purpose.
- To my church family - thank you for your ongoing support. Hopefully submission of this document will facilitate my becoming a ‘Doctor Doctor’ – i.e., the embodiment of a bad joke - how ‘ironical’ that took so long. Maybe now I’ll stop talking about it.
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Till next time !

Abstract

In 2008 I first developed a module entitled ‘MM258 - An introduction to the Management of Information Systems’, which was designed to get pre-experience undergraduate Accounting, Business, and Management students to think about how information systems (i.e., people / management systems, organisational systems, and technical system) are used in business. Having come from a technical / engineering background, I found Information Systems (IS) textbooks often overly simplified, however it became clear that some students struggled with complex abstract and system-of-systems thinking.

The study is split into three parts: In part one I present the reader with a brief introduction to information system and educational literature, defining a constructivist / structuralism view that i) human cognitive develops occurs over time, ii) that development progresses through definable stages, and iii) that not all people go through all stages. In part two I consider UG student understanding of three IS models – already taught as part of the MM258 module – i.e., i) Nadee et al.’s (2017) dual-aspect model, which introduces students to the idea of business norms and norm conflict, ii) Ventatesh et al.’s (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex fixed dependency models considering technology system acceptance, and ii) Pankratz and Basten’s (2013), which introduces students to a complex theoretical failure model, which presents from literature 54 failure factors in a matrix of categories and dimensions that result in information systems failure; i.e. to determine whether student understand the systems model being taught to them. In part three I iteratively develop a holistic systems model to support the teaching of complex systems-based theory to pre-experiences UG students. Although data collection was limited by practical sessions, results suggest that students can understand the dual-aspect model and UTAUT2 models, however the UTAUT2 was found to be contextually restrictive. The theoretical failure model, proposed by Pankratz and Basten, was not fully appreciated by students, resulting in students assimilating a simplified model based on temporal stages (planning, implementing, other factors). Accordingly, the Nadee et al. model was selected for use as the Kernel theory, i.e., Artefact 1.

In artefact 2 issues and conflicts highlighted in the Nadee et al.’s dual aspect model are addressed, resulting in a significant restructuring of Why (Conceptual), How (Informal and

Formal), and What (Technical) norm levels. In artefact three I added system goals and consideration of external influences (for artefact 3 – see section 5.3), iii) adding an inner world model (for artefact 4 – see section 5.4), iv) the handling of norm conflict (for artefact 5 – see section 5.5), v) consideration of the IPO model (for artefact 6 – see section 6.2), vi) explicit consideration of behaviour and communication (for artefact 7 – see section 6.3), vii) inclusion of emotion (for artefact 8 – see section 6.4), and finally addition of motivation, and extensibility (for artefact 9 – see section 6.5). With each artefact iteration, the model addresses a wider range of information system issues. Accordingly, in section 6.6, I provided a final design science evaluation, as required in the Vaishnavi and Kuechler (2004) methodology, i.e. to test i) whether the holistic model can be used to represent the concepts contained within the three models used in the MM258 module (Nadee et al., 2017; Venkatesh et al. (2012); Pankratz and Basten, 2013), and ii) to provide Formal Expert Elicitation in order to get feedback for relevant domain experts. In section 6.7 I provide a conclusion to the chapter.

The thesis provides a conclusion (in chapter 7.1 to 7.4) that i) critically considers the research design, methodology, and research contributions (theoretical, methodological, practical), and ii) considers what future research and development is required in this domain. Finally (in optional section 7.5) I provide a personal reflection concerning the DBA journey, highlighting openly his thoughts about each stage in the DBA journey

Table of Contents

Table of Figures

Table of Tables

Appendix

List of Common Abbreviations

IS	Information Systems
UG	Undergraduate
RQ	Research Question
IPO	Input-Process-Output
TPS	Transaction Processing Systems
MIS	Management Information Systems
DSS	Decision Support Systems
ESS	Executive Support Systems
OTS	Off the Shelf
ERP	Enterprise Resource Management
DBMS	Database Management System
CRM	Customer Relationship Management
SWAG	Sophisticated Wild-Ass Guess
TPB	Theory of Planned Behaviour
TAM	Technology Acceptance Model
UAI	Uncertainty Avoidance
UTAUT	Unified Theory of Acceptance and Use of Technology
PE	Performance Expectancy
EE	Effort Expectancy
SI	Social Influence
FC	Facilitating Condition
PV	Price Value
HM	Hedonic Motivation
HB	Habit
DSR	Design Science Research
CN	Current Norm
NN	New Norm
TN	Target Norm
ATTN	Attitude to Target Norm
ATCMB	Attitude towards Change in poor behaviour or Maintenance of good Behaviour

Chapter 1
Introduction

1.1. Research Motivation

A doctorate is not an award, it is a research journey. When I told people that I had started a second doctorate, most people thought I was crazy. Although this might be true, it occurred to me that a DBA (a Doctorate in Business Administration) offered potentially a very different journey to the one that I had experienced in my PhD. A DBA, which is primarily for academic professionals, is distinctly different in nature from a PhD, which supports the development of professional academics. The purpose of a DBA is to solve a practical problem relating to professional activity; accordingly, it is critical that the reader keeps in mind that the outcome of this research is focused on development of a useable solution.

In 2008 I accepted the role as a lecturer within the Informatics Research Centre (IRC) at Henley Business School (University of Reading). One of the first tasks I faced was to development of a taught module entitled ‘MM258 - An introduction to the Management of Information Systems’. This module, via adoption of a sociotechnical perspective, introduces undergraduate Accounting, Business, and Management students to the complex domain of information systems in business, i.e., i) to provide students with an appreciation that people, technologies (hardware and software), and organisations can all be considered ‘information systems’, and ii) that effective management (integration and alignment) of systems is critical to modern business outcomes. Two people talking can be seen as two information systems interacting. A business integrating a new computer system can be seen as the conflict and alignment of two information systems, etc. Information systems interaction is therefore literally everywhere!

Interestingly, and despite my best efforts, a consistent proportion of UG pre-experience students that I taught struggled to appreciate the complex interplay of systems, which is critical to appreciating the effective management of information systems in business. Moreover, when discussing information systems implementation success, some students found it hard to fully appreciate how different stakeholders could perceive the same project outcome differently - with some struggled to see that the same project, from different perspectives, could be over budget (a failure), on time (a success), yet satisfy only 80% of requirements (a partial success). As such, the effectiveness of systems was relative to the perspective of the stakeholder – and that success is subjective to perspective; and is not a concrete concept.

For a long time, I thought that student confusion was due to my teaching, and poor provision of learning content; however, since there was a high standard deviation in module assessment results, it was clear that some people got it and others did not. Why was this? It seemed to me that this practical problem could not be solved by just adjusting my use of teaching methods.

1.2. Research Background

The term 'system' is widely used yet can be loosely defined as a group of 'things' (entities) that work together towards a specific goal or output. In its simplest form, a system contains: i) a boundary, which defines the scope of the system, ii) Inputs, which define what information and resources enter the system, iii) Processes, which is a black-box description of what inputs are transformed, and 'how' they are transformed by the system; iv) Outputs, which is what the system produces, iv) and (optionally) feedback, which supports development and learning (Laudon and Laudon, 2011). This Input-Process-Output (IPO) definition of a system can be applied to any system. Accordingly, a system can be as large as a planet, as complex as a person, as formalised as a computer, or as small as an atom. Moreover systems, which are whole and complete, may interact with other complete systems, as parts of a larger system, forming a complex system-of-systems. As such a system may be termed as a 'holon', a term first use by Koestler (1964) yet later popularised by Wilber (2007). A holon defines that a system can be simultaneously whole (in and of itself), yet also part of a larger whole (a part of something larger).

An organisation, for example, is a collection of people, processes, and technologies (all separate systems) that interact together within a changing world, working towards a valued outcome (Buttle, 2009). Organisations, however, are impacted by the actions of existing competitors, new competitors, new technologies, customer demands and expectations, and supplier issues and problems (Porter, 1979, 2008); and are therefore themselves part of a larger societal system, etc. etc. etc. The ability of an organisation to deliver a successful output is, however, dependent upon it ensuring successful access to the correct inputs from the environment (information and/or resources), and the ability of internal holons – e.g., people and technological systems – to successfully process and transform the inputs into a desired output. If the inputs are not available, then the organisation will need to either find an alternative input (information / resource) or the output will be negatively impacted. If inputs are available, yet internal systems (people and technologies) are either i) unable to process these inputs, ii) unwilling (or able) to adopt, use, or interact with current systems, iii) unable to adapt the system to incorporate environmental change, or iv) internal holons fail to function together as a single whole, then the output of the organisation will be negatively impacted. If the output cannot be achieved then value is not created, and the larger organisation is at risk of failure, which in turn will negatively impact lower component parts. If the output is incorrect, or the output no longer satisfies the needs and requirements of external stakeholders (e.g., customers, regulatory bodies, etc.), then inputs and/or processes either need to change, incorporating feedback, or similarly the long-term survival of the organisation (and dependent internal holons) are at risk.

If the norms of multiple holon systems (e.g., people, organisation structures, and technologies) misalign, then conflict will exist. Where conflict exists, alignment can be achieved only by changing one or both systems. For example, if an organisation were to purchase an Enterprise Resource Planning (ERP) system, yet the configured best practice processes failed to align to the intended business processes, then either the ERP needs to be customised, which can be risky and expensive, or the company business processes needs to be re-engineered to fit the new software. Similarly, if a formalised information system were to be mandated by the organisation, despite the local branch having developed different processes, then i) the system is not effectively used, ii) the processes will have to be changed towards standardisation (at the risk of losing local specialisation), and/or iii) staff use system workarounds. Moreover, since the boundary of dynamic systems is often in flux, the definition of formalised system boundaries will rarely satisfy all stakeholders. The list of potential IS issues is extensive and explaining this range of ideas within undergraduate (UG) education requires the use of several IS models and tools. For example, within the MM258 'Introduction to the management of Information Systems' module seminars Nadee et al.'s (2017) dual-aspect model is discussed when introducing students to the idea of business norms and system conflicts; Ventatesh et al. (2012) extended unified theory of acceptance and use of technology (UTAUT2) model is used to consider technology system acceptance factors; and Pankrazt and Basten's theoretical failure model (2013) is presented to students to demonstrate the range, categories, and dimensions impacting information systems failure.

To try and understand this in more detail I read extensively around educational and psychological literature (presented in chapter 2). Interestingly Kegan (1982), who describes 5 levels of adult mental development - 1) Impulsive Mind, 2) Instrumental Mind, 3) Socialised Mind, 4) Self-Authoring Mind, and 5) Self-Transforming Mind – showed that not all adults, in fact most adults, do not reach beyond levels 3 or 4 – and do not therefore reach their cognitive potential. Level 3 relates to possession of a 'socialised mind', which normally develops at puberty; and is where an individual's thoughts, beliefs, and actions are heavily influenced by the thoughts, beliefs, and actions of others that surround them. People with a socialised mind believe that 'fitting in and following along' is best, and that not fitting in is potentially dangerous and/or wrong. Kegan's stated that approximately 58% of adults live their lives at level 3. Level 4 relates to individuals who develop a 'self-authoring mind', which Kegan (1982) explicitly said is essential to fully appreciating complex multi-dimensional and systems-based problems. Kegan claimed that transition to level 4 is achieved by approximately 35% of adults, yet that this transition normally occurs later in life - i.e., between 20 and 40 – yet is dependent on the development of a more complex mental model of the world.

In this research I suppose that a considerable proportion of my pre-experienced undergraduate MM258 students, who are aged approximately 20, struggle to perceive complex system thinking because they have not yet developed a fully critical 'self-authoring mind'. A self-authoring mind is a mind that i) does not rely on, and is not primarily driven by the norms (i.e., belief, rules, and actions) of external influences, ii) is able to fully appreciate the simultaneous existence (and importance) of multiple independent yet interacting system world views – i.e. that two people can agree to disagree - and iii) that appreciates the impacts and interplay that exists within and between different systems when system (people, technology, and organisational) norms misalign.

1.3. Research Problem

From consideration of the literature (see chapter 2), I determine that it is critical to assess how pre-experience students perceive a range of IS model, i.e., to i) understand deficiencies in understanding, and ii) to allow the development of a holistic systems model to support the teaching of key information systems concepts to pre-experience students. Instead of using a different model to teach separate IS ideas, it is the aim of this research to develop a single holistic model that allows a range of IS concepts to be constructively and systematically presented to students; allowing students to focus more time on the concepts and ideas being taught - instead of (each time) having to learn a different model ontology.

1.4. Research Questions

Two research questions (i.e., RQ1 and RQ2) were developed:

- Research Question 1 (RQ1) - "Do MM258 students understand the systems models currently being taught to them?"
- Research Questions 2 (RQ2) - "Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?"

1.5. Aim / Objectives

Accordingly, the aim of this thesis is to iteratively develop a single holistic information system model; i.e. to help UG pre-experienced students to better appreciate, via constructive learning, the complex system ideas required to appreciate the management of information systems in business. To achieve this aim, the following objectives were defined:

- Conduct a systematic literature review to understand current thinking in system, education, and information systems education.
- Design, develop, and undertake data collection to collect data concerning pre-experience management students understand of several current information systems models.
- Analyse collected data to i) evaluate what students perceive when considering information system models, and ii) determine a kernel theory (which students do understand) that can be used as the base for development of a single holistic information systems model.
- Iteratively develop a unified model, which is i) simple enough to be used with UG teaching, ii) structured enough to incorporate a range of key literature, and iii) extensible to allow future development.

1.6. Thesis Structure

The thesis is split into three parts:

Within PART 1, after an introduction to the thesis (described above), I provide a justification of i) the research problem (chapter 2), and ii) the research methodology (chapter 3) used throughout this research.

Within PART 2 (chapter 4) I address RQ1, by (within MM258 seminar sessions) quantitatively collecting data assessing student understanding of the system models. Three existing IS models – 1) Nadee, et al.'s (2017) dual aspect model which introduces students to the idea of business norms and norm conflict, 2) Venkatesh et al.'s (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex dependency model considering technology system acceptance, and 3) Pankratz and Basten's (2013), which introduces students to a complex theoretical failure model – were considered. Appreciation of student understanding is key to selection of the kernel theory; used as artefact 1 in the development of a holistic system model.

Within PART 3 I consider RQ2 by iteratively developing the kernel theory (artefact 1), by: i) re-considering the layout of Why, How, and What (in artefact 2 in section 5.2), ii) adding system goals and consideration of external influences (in artefact 3 in section 5.3), iii) adding an inner world model (see artefact 4 in section 5.4), iv) the handling of norm conflict (in artefact 5 in section 5.5), v) consideration of the IPO model (in artefact 6 – see section 6.2), vi) explicit consideration of behaviour and reaction (in artefact 7 in section 6.3), vii) inclusion of emotion (in artefact 8 in section 6.4), and finally addition of motivation, morals, and extensibility (in artefact 9 in section 6.5). With each subsequent artefact iteration the model addresses a wider range of information system issues. In section 6.6, I provided a final design science evaluation, as required in the Vaishnavi and Kuechler (2004) methodology, i.e. to test i) whether the holistic model can be used to represent the concepts contained within the three models used in the MM258 module (Nadee et al., 2017; Venkatesh et al. (2012); Pankratz and Basten, 2013), and ii) to provide Formal Expert Elicitation in order to get feedback for relevant domain experts. In section 6.7 I provide a conclusion to the chapter.

In chapter 7 I provide a conclusion that i) critically considers the research design, methodology, and research contributions (theoretical, methodological, practical), and ii) considers what future research and development is require in this domain. Finally I provide a personal reflection concerning the DBA journey.

Good Luck!

PART ONE

A Review of the Background
a Definition of the Problem,
and
a Discussion of the Methodology.

Chapter 2
Background
and
Problem Definition

2.1. Introduction

The term 'system' is used widely in literature, from computing to astronomy, and can be loosely defined as a group of things (entities) that work together towards a specific output or goal. In literature system definitions commonly comprise of 5 component parts: i) system inputs, which define the resource available to the system; ii) system processes, which define how the system functions; iii) system outputs, which define the contribution of the system within the environment; iv) a boundary, which defines the scope of the system, and clarifies the positioning of inputs and outputs, and v) system feedback, which is used within the system to learn whether inputs and process provide an acceptable output. Feedback commonly results in a change to system inputs and processes – with the aim to improving the perceived value of the output, or boundary definitions, to ensure that system scope is effectively defined (Laudon and Laudon, 2011).

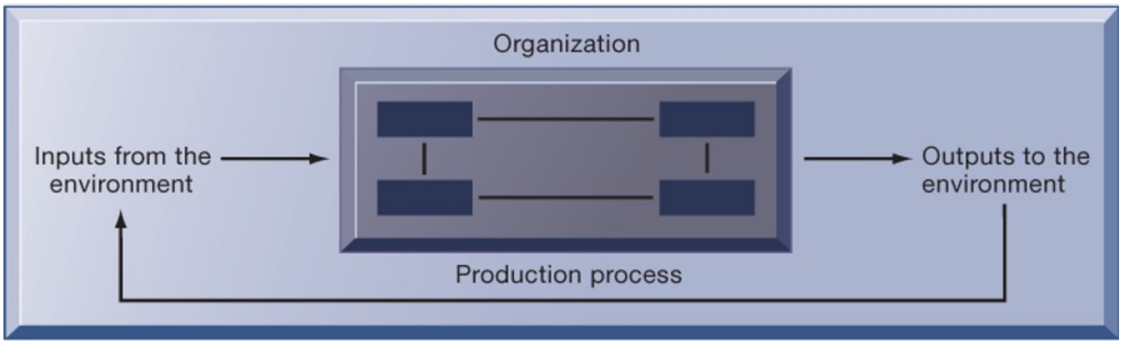


Figure 2.1. The Input / Process / Output Model adapted from Laudon and Laudon (2011).

Using this Input-Process-Output (IPO) model definition allows us to define organisations (see figure 2.1), technologies, and even people as systems (Liu, 2000). Indeed, the world and everything in it can be broken down and perceived as an interplay of systems. A business, for example, takes physical and / or informational inputs and processes / transforms this input – via processes that require both skills of individuals and/or the action of devices or software (both systems) that create a desired business output (see figure 2.1). The output of the business, i.e., the value proposition created by the business, is hopefully purchased by the customer (a system), who then uses it as an input within their processes, which in turn adds value… etc, etc., etc. A clear definition of the 'system boundary' is critical, since definition of the system boundary in turn defines system Inputs, Processes, and Outputs. A system can therefore (in theory) as large as the Universe, as complex as a person, as formalised as a computer, or as small as a cell. Moreover systems, which are whole and complete (i.e., a holon), can potentially interact with other complete systems, to form a larger system of systems. For example, a business is influenced by the activities of i) external systems (Porter, 2008) - e.g., governments, disruptive technologies, etc. - and ii) internal systems – e.g., staff skills, culture, and availability to tools and equipment. If humans are systems, organisations are systems, and technology are systems, then understanding the interplay of systems is critical to most human activity and learning. Understanding systems, and introducing US student to the interplay of systems thinking, lies at the root of the focus MM258 module.

To provide the reader with context concerning the focus module, it is important to provide some introductory information concerning the evolution of the MM258 module, the teaching methods, the students, and the assessment practices. The MM258 module, entitled 'An introduction to the management of information systems' was commissioned in September 2008 to be an optional part 2 module (attended by about 20 accounting students) to i) to provide students with an appreciation that people, technologies (hardware and software), and organisations can all be critical to 'information systems', and ii) that effective management (integration and alignment) of systems is critical to modern business activity. The MM258 module descriptor states that MM258 '*introduces students to the fundamentals that underline the design, implementation, control, evaluation, and strategic use of information systems in business. After introducing conceptual foundations underlying information systems, the course considers, from a business perspective, categories of information systems and their purpose in modern business. Although the course considers some information technology issues, the course aims to deliver a socio-technical perspective of information management from a management perspective."* At the end of the module students should be able to *"a) Identify the fundamental concepts and theoretical constructs concerning management of Information Systems (IS); b) Describe the capabilities and limitations of the technology upon which IS is* *structured; c) Consider and appropriate theories and models related to business and competitive effects of IS strategies; d) Discuss and analyse issues involved with the development and use of an organisation's information systems resources: data, information, application systems and hardware".*

The module (to date) has been taught across 10 weeks, requiring (per week) 2 hrs of face to face taught content (i.e. lectures), at least 1 hour (per week) of interactive seminars (with the number of students broken into smaller groups to support interactivity and discussion), and a weekly list of guided activities and reading. MM258 seminars are used primarily to emphasise key taught points and/or support (using interactive activities) important discussion points, e.g. Why system conflict with each other? What causes IS project failure? Can management of IS prevent project failure? What are the drivers of technology acceptance?

The MM258 module is achieved using two assessments: 1) a 30% 3000 word consulting report – critically reflecting on a complex business scenario; and 2) a 70% 2hr exam, which aimed to test the student's wider knowledge, and ability to apply knowledge in context of a clear problem. Because of the wide module scope, student (in the exam) are asked to answer four of seven possible questions – thus allowing students to select topics with which they are most familiar. The assessment rubrics for all questions are based on Blooms taxonomy: <40 if the student has not met the requirements of the assessment; 40-45% if a solution is stated, but the solution is confusing and/or shows limited understanding; 50-55% if understanding is clearly expressed, but the student does not link understanding well to the problem or scenario; 55-60% applying understanding to the problem. Stating options clearly, but not expanding all positives and negative of options how the problem could be applied / solved; 60-65% expanding positives and negatives of all options, but not always justifying critically why selection was made; 65-70 – giving justification for the decision made, and giving a justified solution, but maybe not giving full details how the solution will be implemented (and why); 70+ – Giving a good description of everything above and a clear plan for the solution.

Due to the growing appetite for digital business solutions, and continued improvement of the module, the number of students choosing the MM258 module grew year on year (in the UK). Currently MM258 has approximately 100 students – from Accounting, and Business and management, degrees. All students are required to acquire APEL equivalent to an ABB in their A-Levels (IB:32 points, BTEC: DDD) to commence these degrees. Overseas students are also required to meet the basic language requirement of IELTS 6.5 (with no component below 5.5 to enter the degree), however all students whose first language is not English are required to also take in-session language training in part 1 of the degree. Accordingly by the time they take MM258 (in part 2), the language ability of attending students is good. In 2014 the MM258 module was included in the new BA Accounting degree - i.e. taught as a mandatory part 2 module at the Beijing Institute of technology by local lecturers. This added approximately 140 students taking the module. Students are only given an offer to join the BA Accounting (BIT) degree if they are within the top 5% of students in the Chinese University Entry exams (GaoKao). As such it is reasonable to assume that all BIT students are academically capable. Moreover, the BA Accounting degree is a four year course, instead of the 3-year course run in the UK. Within this extra foundation year students spent studying i) an introduction to business and management, ii) Academic skills, and iii) International English. If any BIT students fail modules in the foundation year, they are not entered onto the first year of the BA Accounting degree. Similar to the UK, all students whose first language is not English are required to take in-session language training in part 1 of the degree. Accordingly by the time BIT students take the MM258 module in part 2, their language ability is good. All material and assessment is provided in English, and material is consistent between UK and China. Analysis of moderated assessments shows that there is no significant difference in the average (approximately 61%), standard deviation (of about 10), and / or distribution between BIT and UK cohorts, suggesting that student achievement, marking, and moderation is consistent for both BIT and UK cohorts.

The aim of the following sections is i) to introduce the reader to information that is contained in the MM258 module, and ii) cover a range of topics that help the reader better appreciate why the defined research questions were raised. In section 2.2 I provide a high level summary of key information presented within the MM258 module. In section 2.2.1 I consider the true nature of information systems. In section 2.2.2 I describe how and why companies acquire Information Systems. In section 2.3 I consider the issue of IS failure, and introduce a paradox - i.e. despite having detailed models of information failure, some pre-experienced undergraduate (UG) students still struggle to appreciate the interplay of complex systems. To understand the models used in literature to represent student learning, and to help the reader appreciate a range of learning models in existence, I present in section 2.4 a range of educational models. In section 2.4.10 I summarise how raise issued link to MM258, which in section 2.5 results in definition of the research questions and research objectives. In section 2.6 I provide a summary of findings and a conclusion to the chapter.

2.2. Information Systems

2.2.1. Defining Information Systems

To help the reader appreciate the scope and content in MM258, the following introduces information systems, as described within the MM258 module. Laudon and Laudon (2011) defines information systems as 'a set of interrelated components that collect (or retrieve), process, store, and disseminate information to support decision-making the control in an organisation'. Interestingly, when you use the term 'information systems', people in business commonly assume you are discussing information technology. The term 'Information systems' is therefore sometimes used synonymously with 'software', which itself is independent on the use of hardware, data management, and communication networks to support businesses in the functional activity of business. Yet perceiving IS as equivalent to IT ignores the true socio-technical nature of IS.

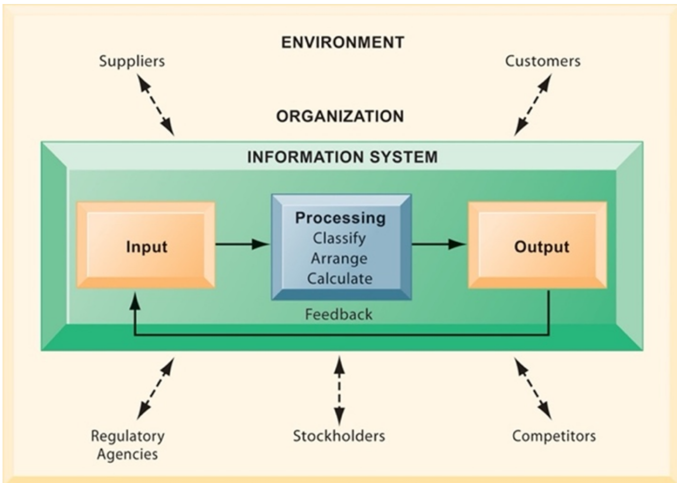


Figure 2.2. The Input / Process / Output Model, explained in context of business; adapted from Laudon and Laudon (2011).

Figure 2.2 shows an input, process, output (IPO) model of a business, and highlights how environmental actors, such as customs, suppliers, competitors, stakeholders, and regulatory agencies, interact with the organisation and its information systems. Accordingly, when considering system requirements, it is critical to consider management, organisational, and technology dimensions. Management make decisions, and formulate plans to solve the organisational problems. The organisation defines the division of labour, authority, and responsibility of people. Technology relates to the tools used to support information processing and transformation.

2.2.2. Information Systems Acquisition

To help the reader appreciate the scope and content within MM258, the following describes how traditional information systems were initially developed, then purchased, as described within the MM258 module. Software designers develop software and tools to support relevant stakeholders (human systems) in the capture, processing, and dissemination of information within organisations. Developed tools (technical systems) aim to capture and process the information and processes that exist within the organisational space. Having an automated information model (i.e., software) is useful to allow business stakeholders to optimise their performance and maximise operational efficiency. A problem occurs, however, because the software solution is static in nature, and therefore - if not updated regularly – they risk adapting to the complex dynamic, ever-changing, real-world information needs of the business environment. Software is called a formalised system, because it represents the world as a set of fixed rules and processes.

Traditionally, due to the dynamic nature of business, organisations would develop small pieces of software - supported by local IT - to support the specific functional needs of key business areas. For example, software might be implemented internally to support the financial and accounting stakeholders to capture, store, process and disseminate financial information to support process efficiency. Over time different functional areas, or management levels, developed disparate tools to support local automation of key business process needs. Although such automation optimises performance, customers are always pushing for greater performance (Kano, 2004). Businesses that wish to survive are therefore driven to continually improve and upgrade their 'systems' to complete, leading to increasing levels of systems complexity. There are many problems, however, with the development of in-house systems.

Most companies who traditionally developed their own software solutions were not by nature software developers, raising questions such as: Why should shoe manufacturer (for example) be expected to possess the skills to capture information systems requirements and / or develop effective software solutions? Moreover, to develop their own in-house software, and keep up with customer expectation, a considerable investment of resources is required (i.e., staff, time, money).

Due to the complexity of most businesses, in-house software often focused on departmental boundaries. Although this makes sense, as the information and processes used within a specific department are often distinctly different, the focus on department-based development (supported by local skills and abilities) can lead to the development of disparate solutions; that are technically and structurally mis-aligned. The tools and solutions that are perceived to be best in sales and marketing, are potentially different from those preferred to support the needs of finance and human resources. As such, if left unmanaged, the solutions (language and tools), technologies, infrastructure, and data management used within each department could potentially be different in different divisions. Each department, if given autonomy, could develop its own information, process, and technology silos, yet such silos limit the flow of information. The investment of resource may result in local efficiency and effectiveness improvements, yet if systems development (at a company level) are poorly managed, then the cost overhead (and the level of systems complexity) is compounded every time a new solution is developed. Moreover, to manage data redundancy and inconsistency, information in multiple systems need to be transformed, projected, and uploaded to achieve data alignment. If a business, however, fails to manage these technology updates, or maintain to synchronise the data in disparate systems (which can be a huge parasitic drain to companies), the business risks no-longer possessing a single version of truth in their data, and (over time) the company risks jeopardising their ability to function effectively (or efficiently) as a whole.

Software companies soon realised that most businesses were i) unable to keep up with the increasing complexity of information systems solution development, yet ii) needed cutting-edge software solutions to meet customer needs. Off-the-Shelf (OTS) software providers were able to develop software, which was constructed from modules. Each module contained a series of best practise processes, which allows different customers to select (and then integrate) the 'best practice process' that most reflects their business activity. Businesses, instead of learning how to develop their own internal systems, purchase a professionally developed generic OTS solutions, such as Enterprise Resource planning (ERP) solutions, which can be configured (with minimum complexity) to meet their specific business needs. All modules are linked to a centralised database structure, and all modules are designed to integrate information between modules. If information is collected within sales, for example, then this same information is available to manufacturing and finance modules, and can be even made available to external bolt-on solutions – such as a customer relationship management or data mining application. By having a centralised database, organisations can then use processes that cross either functional or management hierarchy borders.

One of the key failure factors impacting project success relates to selection of the correct vendor. If the selected OFT solution is unable to provide modules, or best practice processes that support business activity, then the business has to decide whether it will solve the problem by i) customising the enterprise solution (at considerable cost and time), ii) change the internal processes and norms within the business to align to the ‘vanilla’ – unmanipulated - processes that exists within the software, or iii) select a different software solution. Consideration this critical dilemma, in context of a business scenario, acts as the basis for the MM258 coursework assessment (see appendix B1).

2.3. Failure in IS

To help the reader appreciate the scope and content of MM258, the following section describes how failure is presented within the MM258 module. Delivering complex information systems (IS) within a business often results in failure (Lyytinen and Hirschheim, 1987). In the days of solution development, Gladden (1982) claimed that approximately 75% of all developed solutions were either not completed, or were not used; because static solutions failed to support the changing needs of business activity. Technology, business goals, and customer expectations are in always in constant flux. Accordingly, it is important that organisations are constantly updating the formal (static) IS solutions to support their business activity; or they risk finding themselves unable to effectively capture, process, and / or disseminate information through-out the organisation. Moreover, if businesses do not update their solutions, they risk other organisations obtaining a strategic operational advantage, resulting in a loss of their customers.

IS developers traditionally signed up to the fallacy of concreteness, assuming that an IS project outcome was either a success or a failure. IS project success was traditionally measured using the iron triangle (Atkinson, 1999), which judges success against pre-defined success criteria, i.e., budget, time, and requirements (both functional and non-functional). Although simple to appreciate, there are many examples where failure occurred in the project despite considerable planning, or success occurred despite no planning at all (Baker et al., 1988; Ika, 2009; Pinto and Slevin, 1988). Subsequent literature, however, has showed that IS failure is a complex multi-dimensional socio-technical problem, which is defined using multiple KPI dimension, e.g., Time, Cost, Quality, Stakeholder satisfaction, satisfaction of project goals, etc. (Baccarini, 1999; Lyytinen and Hirscheim, 1987; Panthurst and Basten, 2013). Moreover, definition of whether the project is a success or failure, is impacted significantly by the perspective, role, and horizon of each project stakeholder; and each has a separate opinion concerning whether the outcome is a success. For example - If you are the finance director, then you might perceive the project as a failure if the project goes over budget. If you are the project manager, then you might perceive the project as a failure if the project goes overtime. If you are a customer, then you might perceive the project as a failure if key requirements were not met.

The focus of failure, and the perception of success, have shifted over time, i.e., to reflect change in use of development lifecycle, complexity, and implementation focus used in businesses. Traditionally information systems were developed using a traditional waterfall development lifecycle approach, where explicit requirements were defined at the beginning of the process, and subsequent design, implementation, testing, and deployment stages were required before the systems could be used to support business activity. In such projects the scope of the project was normally explicitly defined, however the development duration impacted the chance that the final solution – when delivered – would still be relevant within the ever-changing business domain. The delay could circumvented by increasing the investment of resources, but this reduced the funds available for development of other growth areas, and reduced the gained value - as the value is defined as the benefit gained divided by the resource invested.

Recent literature provides numerous models and studies considering IS failure (Lyytinen and Hirscheim, 1987; Pinto and Mantel, 1990; Flowers, 1997; Panthurst and Basten, 2013). The model considered in the MM258 module (i.e. Pankratz and Basten, 2013) collected together failure case studies from a range of top IS journals and periodicals; including European Journal of Information Systems, Information Systems Journal, and MIS (for a full list of journals see appendix A1 table A1). In total 15 cases were considered from 17 articles (see table 2.1), with failure examples represents a range of dates (between 1978 and 2009). Pankratz and Basten conducted data-driven qualitative analysis, in line with Jankowicz (2004), and proposed a saturated list of failure factors. Analysis of each paper, in turn, allowed Pankratz and Basten to identify i) the factors impacting failure, ii) what stakeholders were involved in that failure factor, and iii) that potentially multiple failure dimensions (i.e., time, cost, quality, process efficiency, satisfaction with the process, strategic goals, end-user needs, and satisfaction with product) are impacted by the existence of that factor.

Table 2.1. Identified Cases (adapted from Pankratz and Basten, 2013).

#	Case	Article(s)
1	Sophisticated IS to modernize air-traffic control in US	Barlas 1996
2	Electronic work time registration system in Central-Eastern Europe	Bartis and Mitev 2008
3	IS to enhance organ procurement and placement in US	Beard et al. 2006
4	IS to improve effectiveness and efficiency of Common Agricultural Policy grants and subsidy administration in the public sector in UK	Berger and Beynon-Davies 2009
5	IS to automate processes of manual dispatch systems associated with ambulance services in the UK	Beynon-Davies 1995; Fitzgerald and Russo 2005
6	Executive IS to monitor business performance in a large manufacturing and distribution organization in New Zealand	Bussen and Myers 1997
7	Integrated case file information system for the FBI	Goldstein 2005
8	IS to computerize commercial lines in an insurance company in US	Hirschheim and Newman 1988
9	Expert system to help sales representatives of a large computer company to produce error-free configurations	Gallivan and Keil 2003; Keil 1995
10	Integrated IS to re-engineer requisitioning at a food producer in US	Kirby 1996
11	IS for all Danish universities to streamline university administration and evaluate institutional performance	Mähring et al. 2008
12	IT-based baggage-handling system at Denver International Airport	Montealegre and Keil 2000
13	IS to support a comprehensive reservation program combining airline, rental car and hotel information in the travel industry in US	Oz 1994
14	IS for better land planning of a state planning agency	Schmitt and Kozar 1978
15	Nurse management system at the Eldersite Hospital in England	Wilson and Howcroft 2002

Pankratz and Basten conducted a systematic literature review of 15 IS failure case studies, and, using thematic analysis, proposed 54 distinct failure factors (see appendix A), which they mapped within a theoretical multi-dimensional model consisting of 10 categories: 1) conditions that are present at project initiation (i.e., a lack of clear responsibility concerning IT, high system complexity, a climate of mistrust, and unclear strategic goals); 2) incorrect directive decisions that impact project course (i.e., requirements not regulated contractually, a lack of acceptance criteria, insufficient contractor experience, prolonged contracted competition, and replacement of the contractor); 3) insufficient consideration of the customer (i.e., system does not fit culture of customer organisation, inappropriate development approach, system does not seek customers strategic goals, requirement discrepancies amongst user groups not considered, and developers lack of understanding concerning user needs); 4) inappropriate or poor project planning (i.e., unclear project goals, false business case, lack of time planning, underestimation of effort, and lack of overall IS plan); 5) project management factors (i.e., inexperienced project manager, inadequate requirements specification, development approach not understood, project management method applied incorrectly, ineffective communication, loose control, prolonged development, management forces fudging status reports, and insufficient quality assurance); 6) poor change management (i.e., users lack of experience in using IT, changes in traditional routines and practises redistribution of power, insufficient stakeholder involvement, low morale of end users, inadequate training, limited prestige and status of project champions, disregarding different perceptions of stakeholders, IT is considered as a magic bullet); 7) poor top management attitude (i.e., insufficient top management commitment, decision frame of key decision makers influenced by prior successes, stakeholders responsible for project not open for problems / criticism, disregarding external advice, and ignoring alternative solutions); 8) inappropriate consumer contractor relationships (i.e., uncooperative relationship between customer and contractor, too much trusting contractor, too much pressure on contractor, and too little accountability demanded from contractor); 9) technology issues (i.e., technical problems, limited technology, technological uncertainty, and poor system quality); and 10) unexpected events (i.e., knew legal regulations, key staff changes, late changes of requirements, and supplier delays). For a detailed description of the failure factors considered in Pankratz and Basten (2013) paper, please see appendix A table A4-A13). These tables demonstrate that categories of Information Systems failure, are impacted by multiple factors. Although complex, the Pankratz and Basten provides an extensive consideration to IS failure.

Despite our knowledge of IS failure causes, IS implementation failure is still a huge problem. In an attempt to quantify the size of the total cost of failure, Roger Sessions (2009) published a white paper that expounded the cost of IT failure in the modern world. He claimed that countries across the globe spend (on average) 6.4% of the Gross Domestic Product (GDP) on Information Communication Technology, with 43% of this total spent on hardware, software, and services. Interestingly, it was estimated that up to 65% of all projects (in 2009) failed. Session estimated the annual cost of IS project failure to be around USD 6.18 trillion worldwide (Sessions, 2009), which equates to approximately 500 billion per month. Cost to the US, who at the time of writing had a national debt of 26.95 trillion, was approximately 1.2 trillion per year. In the UK, the cost was estimated to be approximately 200 billion, which equates to approximately £2000 per person per year, i.e., every man, woman, and child, in the UK per year. Session openly admitted that the cost numbers were a SWAG (Sophisticated Wild-Ass Guess), and were high as they included lost opportunity cost, but were as close as possible to demonstrate the orders of magnitude caused by global IS failures problem.

To appreciate the impact of IS failure, it helps to put this into perspective. Ceres2030 (see https://ceres2030.org/), a partnership of academic, civil engineers, and economist, estimated that it would cost approximately $330 billion to develop sustainable solutions to solve world hunger by 2030. The World health organisation also estimates that it would cost about $58 per person, per year to achieve essential basic universal health care in all low and middle income countries; i.e. $371 billion per year. Accordingly, we could end to world hunger, and provide a basic universal global healthcare by 2030 with just 7% of the wealth that is wasted (each year) by organisations and governments on IS project failure. Imagine what we could do with the other 93% - if only a consistent reduction could be made in the level of IS failure.

If information is known about the causes of failure,
why does Information Systems failure keep happening?

In the MM258 module, multiple models are introduced to students in order to support discussion of different issues that exist when implementing, adopting, and interacting with business information system issues. These model include: 1) Nadee et al. (2017) dual-aspect model, which introduces students to the idea of business norms and system conflicts; 2) Ventatesh, et al.'s (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which considers the factors involved in technology system acceptance factors; and 3) Pankrazt and Basten's theoretical failure model (2013), which is presented to students to demonstrate the range, categories, and dimensions impacting information systems failure.

Interestingly, and despite my best efforts, analysis of coursework and exam assessments has shown that a consistent proportion of the UG pre-experience students struggle to appreciate the complex interplay of systems. For example:

4a) Expand in detail four IS implementation failure factors, providing discussion concerning the implications of each factor, and how each factor might be avoided. (16 Marks)
{taken from the 2017/18 resit BIT/UK resit}

Questions that require students to critically discuss i) issues that resulted in failure, ii) the interaction between complex systems (human, computer, and/or organisational), or iii) explain the limitations of system models (e.g. Ventatesh etl al. (201) or Pankrazt and Basten), resulted in a bi-polar distribution of grades (see figure 2.3a), instead on the normal (and expected) distribution (see figure 2.3b). But why?

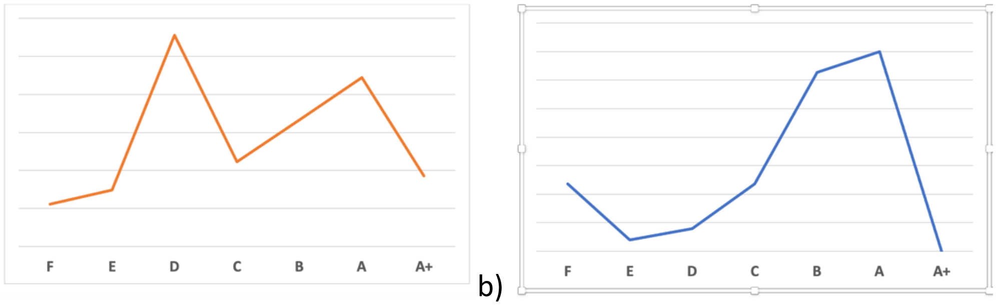
a) b)


Figure 2.3. Distributions of MM258 exam students – a) example complex system distribution, and b) normal distribution.

I initially reasoned that a bi-polar distribution for such questions occurred because students were simply disinterest in this type of question, yet each MM258 student only has to answer four of a possible seven questions offered; implying that all students had chosen to answer these questions in preference of other options. I also wondered whether the need to write more critically impacted student ability, however i) all students (in both UK and BIT) have undergone considerable admission checks (for both academic and language ability), and ii) students appeared very capable on questions where complex interplay of system was not considered.

Interestingly, when discussing information systems implementation success (within the seminars), some students found it hard to fully appreciate how different stakeholders could perceive the same project differently – i.e. that the same project could a failure to some stakeholders, a success to other stakeholders, and/or a partial success to others; dismissing that success was dependant on the critically perspective of the different stakeholders.

MM258 students are required to learn about multi-dimensional information system complexity and information system failure, however some appeared to struggle with this key idea. Although University of Reading students are highly capable, and many will get jobs in high level management roles. Many of our graduates will be involved in the implementation of information systems. If students, fail to appreciate the complexity of system thinking, how will they cope when asked to manage IS projects. Poor management is responsible for a high proportion of failures (Pankratz and Basten, 2003 – see tables A4 -13). I believe that an incorrect semiosis of factors, and factor relationships, results in the mind of students. As such, when such individuals are involved in IS projects for the first time, they (in addition possessing limited experience), also possess incorrect mental models; compounding the problems.

As an educator **what do I need to change in my teaching to support students in developing an effective semiosis of complex business information systems concepts?**

To better understand educational literature, and to try and answer the above question, I considered several learning models. The following section (see section 2.4) presents a selection of education models from literature, highlights some key findings, and ultimately facilitates creation of a research problem, aim and objectives.

2.4. Education Models

When we talk about learning, people often have a mental image of a teacher at a whiteboard didactically presenting material that has been painstakingly turned in to bite sized slides. The term' Learning' however has several definitions, which has resulted in the formation of numerous learning models. In this section the author aims to introduce the reader to several of these learning models, i.e., to better understand how individuals learn new skills or information. I aim to introduce the reader to relevant literature concerning learning models to expound that i) highlight the problems that occur in the teaching of complex systems to pre-experienced students, ii) and discuss how the process of assimilating, and applying information in context of a problem, is core to system modelling.

2.4.1. Kolb's learning Style Model

Kolbs theory of experiential learning evolved from the work of John Dewey, Kurt Lewin and Jean Piaget. Kolb (1973) claimed that learning requires the acquisition of abstract concepts, and that learning styles plays a significant role in at least five main fields – behaviour/personality, educational specialisation, professional career, current job and adaptive competencies. Kolb's learning Style Model, also known as the experimental learning theory (Kolb, 1984), contains four stages of learning and four separate learning styles (see figure 2.4). In stage one, termed the concrete experience, a new experience or situation is encountered by the learning individual, which results in a change to the existing conceptual understanding of objects attributes or entities. Within the second stage, termed reflective observation, the new experience is considered to determine whether the change in conceptual understanding results in inconsistencies between the new experience and existing norm and object structures. Third stage, termed abstract conceptualisation, results in creation of new norms / ideas and / or the modification of the existing conceptual understanding of objects attributes and entities to align and support the new idea. In the final fourth stage, termed active experimentation, the learner then applies the new conceptual understanding of the world, i.e., with the hope that the new world model will better align than that of the old-world model. Effective learning occurs when an individual iterates naturally around these four stages (see figure 2.4), correcting the internal model of the world to align closely to what is perceived and understood from reality.

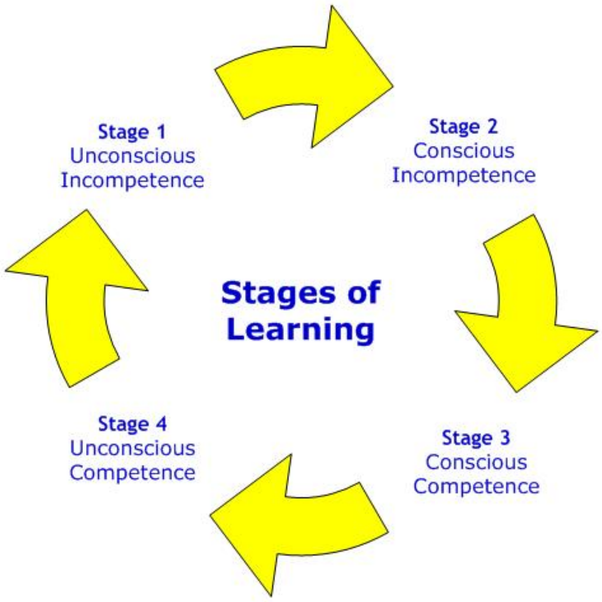


Figure 2.4. Kolbs' four stage learning cycle.

Kolb and Fry (1974) stated that although learners may transition through the same stages of learning, they will assimilate things differently from the real world depending on their learning style. Kolb implied that learning is influenced by two axis i) how we approach a task (called the processing continuum) and ii) how we emotionally respond or feel about something (called the perception continuum). Kolb believed that learners struggle to combine these axis and that the learning style is often the product learning preferences (see table 2.2). By considering whether people prefer to actively do things (AE) or whether they prefer to watch them (RO) and/or whether people prefer to experience the emotional feelings of a situation (CE) or to think abstractly about a situation (AC) we can determine four distinct learning styles: i.e., Accommodating, Diverging, Converging, and Assimilating (see table 2.2).

Table 2.2. Kolb's terminology for the four learning styles (Accommodating, Diverging, Converging, and Assimilating) as a result to Processing and Perception Continuum.

		Processing Continuum	
		Doing (Active Experimentation -AE)	Watching (Reflective Observation – RO)
Perception Continuum	Feeling (Concrete Experience CE)	Accommodating (CE/ AE)	Diverging (CE / RO)
	Thinking (Abstract Conceptualisation - AC)	Converging (AC /AE)	Assimilating (AC / RO)

Accommodating (Doing and feeling) - The type of person who is 'accommodating' is most likely 'hands on' and assimilates information from the world by their own experience, or based on the experiences of others, rather than based on logical analysis. Such people are attracted to new challenges and experiences and seek to carry out and realise the outcomes. Kolb stated that such learners "commonly act on 'gut' instinct rather than logical analysis.", and that people with an accommodating life cycle or more likely to rely on the experience is an information given to them by others rather than carrying out their own analysis. Kolb stated that this learning style was prevalent within the general population (i.e., in America in the 1980s).

Diverging (feeling and watching) - Divergent individuals often appear to look at things with a different perspective and welcome the divergent views and influences of peoples from different social and cultural backgrounds. Diverging learners are often seen as sensitive, i.e., due to their preference to feel rather than logically justify. Moreover, those with a divergent learning style often prefer to watch rather than do. As such divergent individuals are often extremely gifted at solving problems; that require the individual to view the situations from multiple perspectives. Kolb called this style 'diverging' because these people perform well in situations where divergent ideas generation are required.

Converging (Doing and Thinking) - People with a converging learning style are normally considered being practical in their application of knowledge. Converging individuals our best when asked to identify practical uses for existing ideas and theories - as such converging individuals are often seen as logic and rational decision makers. People with a converging learning style will often prefer to focus on the issue of how something is done (i.e., the technical problem), rather than the consideration of social or interpersonal issues; an area where the converging individual is less comfortable. Such people make excellent natural scientists, and business leaders - as they like to experiment with new ideas if they support or help solve a practical problem.

Assimilating (Watching and Thinking) - Assimilating thinkers are most likely to believe that concepts and ideas are more important than specific individuals or people. Such individuals might see the existence of clear and rational explanation as being more important than practical application or inference. Such people are driven by logical thinking and thrive on conceptual reading lectures and ideas. The simulating individuals normally understand a wide range of information and can simulate new information logically in context of existing mental ontologies. Such individuals are often attracted to abstract scientific development.

Kolb's Learning Style Inventory (LSI) data was designed as a tool to assess an individual's preferred learning style based on Kolb's Learning Skills model. The LSI is captured using a survey questionnaire in which participants respond to a series of questions which are designed to assess their preferences when learning and problem-solving. The questionnaire gathers information about an individual's dominant learning style (Converging, Diverging, Assimilating, and Accommodating) by aggregating responses to determine the participant's learning style profile according to Kolb's model.

Kolb’s four stage learning cycle (see figure 2.4) shows that learning is influenced by the context of the learner, and the resultant constructed model of the world is unique. Accordingly two learners, even those taken from the same context, could, as a result of their learning style and perception, focus on assimilation from very different inputs - and therefore develop a very different view of reality.

The LSI has come under criticism since its original formation in 1976. For example Freedman and Stumpf (1978) stated that the test–retest reliabilities of the LSI is volatile, with criticism over the reliability of the classification outcome (Wilson 1986; Veres, Sims and Shake 1987). Ruble and Stout (1992) showed that, although 56% of their respondents maintained the same learning style at the second test, 16% changed to the opposite learning style, raising concerns about the effective reliability of the model of time. Moreover, the latest LSI guide (Kolb 2000) failed to provide detailed statistics, or arguments, justifying the changes identified by Ruble and Stout, instead claiming that *'83.3 per cent of the studies analyzed provided support for the validity of Experiential Learning Theory and the Learning Style Inventory'* (Kolb 2000, 70).

De Ciantis and Kirton (1996) revealed two substantial weaknesses in the work of Kolb. Firstly, they stated that the LSI measure three unrelated aspects of cognition, i.e., i) style - how 'each stage in the learning process is approached and operationalised' (1996, 813), ii) 'process' - the four discrete stages of the learning cycle, and iii) 'level', which is someone's ability to perform well or poorly at any of the four stages. Kolbs construct suggests a separation of the cognitive elements, which is questionable. De Ciantis and Kirton also casted doubt on Kolb's use of the bipolar dimensions {i.e. reflective observation (RO) - active experimentation (AE), and concrete experience (CE)-abstract conceptualisation (AC)}, instead electing to use Honey and Mumford's LSQ instead claiming that it was more reliable.

Another recurrent criticism of the LSI relates to the scoring method. All three versions of the LSI employ a forced-choice method, which Kolb used to increase the validity of the instrument, yet force bipolar selection even when no preference is felt. Moreover, the interdependence of the four learning modes is built into the test, meaning that the learner is forced to select a score for each question, and the outcome is 'ipsative' – the sum of all question outcomes. Researchers have questioned the mapping between the questions and the four learning modes (Wierstra and de Jong, 2002). Mainemelis et al. (2002, 10) responded to these criticisms by arguing that *'in the LSI, the four scale scores (AC, CE, AE, RO) are clearly ipsative, but the two dimensional scores (AC-CE and AE-RO) are not … Learning styles in the LSI are determined on the basis of the two non-ipsative dimensional scores and not the four ipsative scale scores'*.

Kolb (1984) main argument was that the main weakness of current pedagogy is *'the failure to recognise and explicitly provide for the differences in learning styles that are characteristic of both individuals and subject matters'*. Irrespective of the criticisms, Kolbs work highlights that two humans will i) have the same foundational understanding of reality, or ii) assimilate the information 100% consistently. As such a rigid one-size-fits-all model to learning and modelling of student learning is of limited value.

2.4.2. Gregorc Learning Model

The 'Gregorc learning model', which is similar to Kolb learning model, describes two continua describing how individuals perceive and order new information: perceptual preference and ordering preference. Perceptual preference relates to how a learner prefers to assimilate information, and it is similar to the perceptual continuum of Kolb – with qualities defined as either concrete or abstract. Ordering preferences relates to how learners preferred to structure new information - with qualities defined as either sequential (linear) or random (non-linear) – see figure 2.5.

Gregorc (1984, 54) claimed that *"Individuals with clear-cut dispositions toward concrete and sequential reality chose approaches such as sheets, workbooks, computer-assisted instruction, and kits. Individuals with strong abstract and random dispositions opted for television, movies, and group discussion. Individuals with dominant abstract and sequential leanings preferred lectures, audio tapes, and extensive reading assignments. Those with concrete and random dispositions were drawn to independent study, games, and simulations. Individuals who demonstrated strength in multiple dispositions selected multiple forms of media and classroom approaches. It must be noted, however, that despite strong preferences, most individuals in the sample indicated a desire for a variety of approaches in order to avoid boredom."*

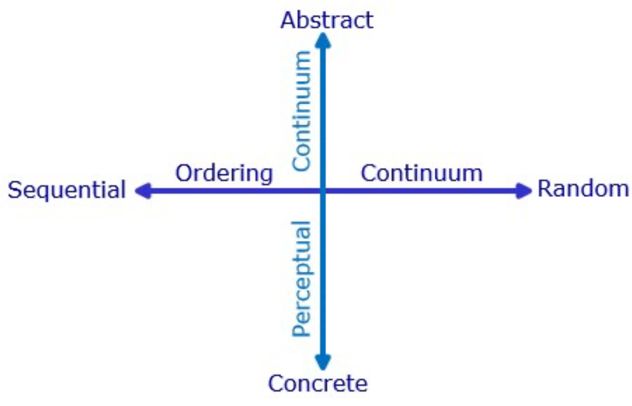


Figure 2.5. Gregorc learning model (adapted from Hawk and Shah, 2007).

Gregorc impies that someone who uses concrete perception will assimilate information primarily through their five senses. Concrete information is therefore (by nature) explicit, and no hidden meanings or connections are expected. If someone uses abstract perception then they will aim to understand ideas or concepts that may not be physically explicit / seen. Sequential ordering relates to a step-by-step procedural interpretation of events, which relies on a logical and systematic train of thought. Random ordering requires the information to be provided and discreet packages to allow processing to be done with no specific order. The four quadrants, shown in figure 2.5, i.e., Concrete Sequential (CS), Concrete Random (CR), Abstract Random (AR), and Abstract sequential (AS), allowed Gregorc to i) propose learner preferences, ii) imply when learners learn most, and iii) identify the conditions when a learner will struggle. For a full list of quadrant learner characteristics see table 2.3.

Table 2.3 - Gregorc Learning Model quadrant learner characteristics.

Concrete Sequential (CS)	Abstract Sequential (AS)
CS learners like: order, logical sequence, following directions / predictability, getting facts.	AS learners like: their point to be heard, analysing situations before making a decision or acting, applying logic in solving or finding solutions to problems.
CS learners are best when: they have a structured environment, they can rely on others to complete this task, faced with predictable situations, can apply ideas in pragmatic ways.	AS learners are best when: they have access to experts or references, are placed in stimulating environments, are able to work alone.
CS learners struggle with: working in groups, discussions that seem to have no specific point, working in an unorganised environment, following incomplete or unclear directions, working with unpredictable people, dealing with abstract ideas, demands to 'use your imagination', questions with no right or wrong answers.	AS learners struggle with: being forced to work with those of differing views, too little time to deal with a subject thoroughly, repeating the same tasks over and over, lots of specific rules and regulations, sentimental thinking, expressing their emotions, being diplomatic when convincing others, not monopolising a conversation.
Concrete Random (CR)	**Abstract Random (AR)**
CR learners like: experimenting to find answers, taking risks, using their intuition, solving problems independently.	AR learners like to: listen to others, bringing harmony to group situations, establishing healthy relationships with others, focusing on the issues at hand.
CR learners are best when: they are able to use trial and error approach is, able to compete with others, given the opportunity to work through the problems by themselves.	AR learners are best when: in a personalised situation, given broad or general guidelines, able to maintain friendly relationships, able to practise in Group activities.
CR learners struggle with: restrictions and limitations, formal reports, routines, re doing anything once it's done, keeping detailed records, showing how they got an answer, choosing only one answer, having no options.	AR learners struggle with: having to explain or justify feelings, competition, working with dictatorial or authoritative personalities, working in a restrictive environment, working with people who don't seem friendly, concentrating on one thing at a time, giving exact details, accepting even positive criticism.

Interestingly, critics argue that the four perceptual qualities and two ordering abilities in the Gregorc model overlap with existing models of cognitive styles (Zhang, 2000), which raises serious questions about the distinctiveness of the Gregorc model. Moreover, although the Gregorc model allows some basic appreciation of the characteristics of learners, and may be useful to some educators, i.e., to understand and categorising students into different quadrant's, the model is considered to be over simplistic (Gould and Caswell, 2006) – i.e., using a dichotomy which many find hard to apply in all areas of learning.

The Gregorc Style Delimiter (GSD), which uses self-reporting questionnaires, was developed to help categorise students (Gregorc, 1984). Students are provided with a questionnaire that contains statements related to their cognitive preferences. Participants typically respond to each statement by indicating the extent to which they agree or disagree with the statement. The response format can vary, but most commonly involves use of a Likert scale with options "strongly agree," "agree," "neutral," "disagree," and "strongly disagree." After completing the assessment, individuals' responses are scored based on a predetermined scoring key. The scoring key is designed to assign values to different response options and calculate scores (as a ipsative sum) for each of the cognitive style quadrants (CS, AS, AR, CR) and ordering abilities (S, R). The scores are then used to generate a profile that reflects an individual's dominant cognitive style and preferred ordering ability. Interestingly Gregorc presents no empirical evidence to support construct validity, and some researchers (e.g. Wiersta and Jong, 2002) questioned the empirical basis of the model. Moreover, as with all categorical models, the process of categorising individuals into distinct styles is arguably overly simplistic, limiting, and rigid (Harasym et al., 1995). Critics argue that human cognition is dynamic and flexible, and individuals may exhibit a range of preferences depending on the context and/or task. Using a fixed styles over simplifies the complexity of human cognition. To the best of our knowledge there are also no independent studies considering the test–retest reliability.

Despite the criticism, the Gregorc learning model, and GSD, highlights that there are multiple types of learning. Some learning is conscious logical and slow (required to provide accurate solution outcomes), and some learning is unconscious, quick, but impulsive. Accordingly, it's essential that any learning model considers both fast (logical) and slow (reactive) learning approaches. Moreover, consideration of different types of learning (and the link to biology) needs to be considered.

2.4.3. Herrmann Brian Dominance Instrument (HBDI) model

The Herrmann Brian Dominance Instrument (HBDI) model, developed by William Herrmann, is defined to measure and describe the thinking preferences of individuals. The first version of the HBDI – inspired by the work of Roger Sperry (Sperry, 1964) – considered only left- and right-brain functionality. The later model (see figure 2.5), however, took into account the work of MacLean (1952), which hypothesised the importance of the brain's limbic system. The Herrmann Brain Dominance Instrument (HBDI) collects data using a self-assessment questionnaire. This questionnaire consists of a series of statements or scenarios, and respondents indicate their preferences or tendencies in relation to these items. The HBDI model aggregated thinking preferences, and the results are used to identify the individual's dominant and secondary thinking preferences. The HBDI question instrument involves 120 online questions, which are used to categorise the learner within one (or more) of the four styles of thinking. The four defined styles are: A) Analytical (or theorist) preferred activities are collecting data analysis, understanding how things work, judging ideas based on facts and critical, and logical reasoning; B) sequential (or organiser) preferred activities are following directions, detailed-orientated work, step-by-step problem solving, organisation, an implementation; C) interpersonal (or humanitarian) preferred activities are listening to and expressing ideas, looking for personal meaning, sensing input, and group interaction; and D) imaginative (or innovator) preferred activities are looking at the big picture, taking initiative, challenging assumptions, creative problem solving, and long term thinking. HBDI model uses participant self-reporting questions to categorise (using proprietary mechanisms) participant thinking into dimensions that represent the lateralisation of brain functionality, i.e., where analytical and sequential styles are associated in the left brain and interpersonal and imaginative styles are associated with the right brain. A and B together define the ration (or left brain) dimension. A and D together defined the theoretical (or cerebral mode) dimension. B and C together define the realistic (or limbic) dimension. And C and D together define the intuitive (or right brain) dimension – see figure 2.6.

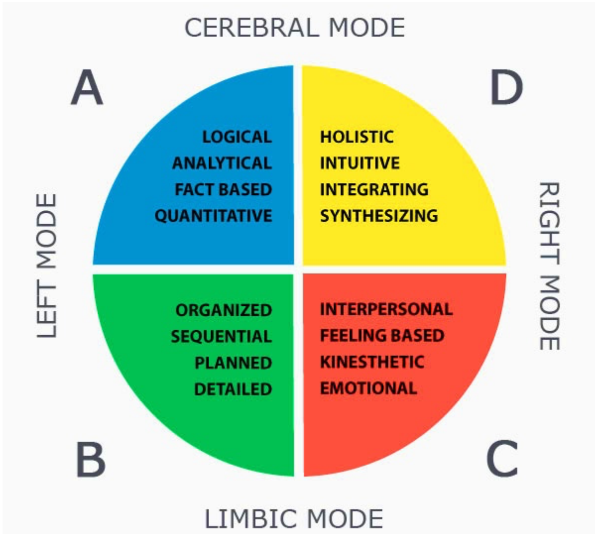


Figure 2.6. The Herrmann Brain Dominance Instrument (HBDI) (adapted from Herrmann, 1989, 2000).

Self-reported questions, and the lateralisation model of brain functionality have both been criticised (e.g., Hines, 1991), which limits the contextual value of this model in our work. Herrmann's model, at a conceptual level, shares many important features previously mentioned models, e.g. Gregorcs Mind Style Model, yet unlike Gregorc's model, there is relatively strong factor analysis to validate findings (Bunderson, 1989).

The Herrmann Brain Dominance Instrument (HBDI) model promotes the concept of "whole brain thinking," emphasizing the importance of utilizing all four quadrants to address complex challenges. It encourages the recognition that a range of different thinking styles is required, and that multiple approaches can be taken to effective creative thinking and problem solving. Accordingly it is essential that the final model can effective consider, and capture consideration concerning the biological aspects of system think.

2.4.4. 4Mat Learning Model

In the 4Mat learning model, created by Bernice McCarthy (1990), Kolbs learning style quadrant's are allocated an equivalent terms and numbers (1 - Diverging, 2 - Assimilating, 3 - Converging, and 4 – Accommodating) – see figure 2.7.

Figure 2.7. 4Mat learning model quadrants (adapted from McCarthy, 1990).

The capture of 4MAT data involves assessing individuals' preferences and tendencies in each of these quadrants. Approaches used include: surveys and questionnaires, where participants are asked to complete surveys or questionnaires designed to assess their preferences in terms of why, what, how, and what if learning styles; feedback statements (or scenarios) that individuals can respond to; observations, where trainers or educators observe participants in learning situations to identify their natural inclinations; interviews, requiring open-ended one-on-one interviews to delve deeper into an individual's learning preferences; as well as self-assessment, where individuals may be asked to reflect on their own learning preferences.

The 4Mat learning model implies that people focus on different aspects of a question. Divergent individuals (quadrant 1) engage with the problem by raising the question why something happened. Such people are often good facilitators within the learning environment because they questioned why the situation occurred. Simulating individuals (quadrant 2) engaged with collecting and sharing the detail of what happened in a specific context. Determining what happened is something that can be empirically proved, thus facilitates a better understanding of the situation as it is for all other groups. Such people are often seemed to be good presenters and sharers of material. Converging individuals (quadrant 3) are linked to how something happened. Such people are often more practically focused and therefore are interested in the mechanisms of technical implementation. Such people are often seen as practical, and often go to considerable lengths to understanding how things happened, so that the best practise can be coached or passed on to other individuals. Accommodating individuals (quadrant 4) focus on the what if aspect of the question. Such people often focus on evaluation of alternatives and look at the problem from multiple probabilities to understand the likelihood of the current situation and or what future situations might occur. The four quadrants are sometimes labelled using imaginative (1 - why), analytical (2 - what), common sense (3 – How), and dynamic (4 – what if) learning skills.

Similar to the HDBI model, the 4MAT model uses right- and left-mode techniques of brain, process iteratively at all four stages, to engage consideration the 'whole brain' thinking. According to McCarthy, *'this (1234) cycle [see figure 2.7] appeals to learner's most comfortable style, while stretching them to function in less comfortable modes. The movement around this circle is a natural learning progression'* (1990, 33). The theoretical base for the 4MAT cycle is the work of Kolb (1999) who was adamant that all four phases were necessary for effective learning, but conceded that '*different learners start at difference places in this cycle'* (1999, 3). Unfortunately, the statistical analyses of Wierstra and de Jong (2002) questioned the structure of Kolb's model, which raises question about the validity of the 4MAT model.

In the context of this research it is interesting that 4MAT learning model suggests that different people have different foci. Some focus on why something happens (imaginative learners), some focus on what happens (analytical learners), some focus on how something happens (common sense), and some, instead of looking at the current, consider the goal of what might be (dynamic learners). This preference in a focus between conceptual, informal, formal, or technical norms suggests that there is a need for to i) make clear norm distinctions, and ii) be able to identify the motivation of different learners.

2.4.5. Piaget's Theory of Education

Jean Piaget was a child psychologist who focused on understanding child development. Piaget proposed the existence of three types of knowledge: physical knowledge, logical and mathematical knowledge, and social knowledge (Piaget, 2005). Physical knowledge refers to appreciation of 'objects in the world'; identified by individuals through perceptual properties. Physical knowledge can be directly expressed in practical experience. Logical and mathematical knowledge is abstract, however can be considered by applying appropriate rules and schemas; for example simple mathematics, and the simple representation of numbers, are abstract constructs that can (if reason is followed) help identify cause and effect relationships and/or solve problems. Social knowledge is culture centric in nature and often requires systematic learning in context of this specific cultural group.

As a result of numerous experiments Piaget developed a theory of human cognitive development, termed Genetic epistemology or ‘developmental theory of knowledge’, which unifies the traditional constructivist and structuralism views of learning. Constructivism thinking, supported by many schools of thought, suggests that human learning is an actively dynamic process where the mind actively creates objects and attributes, and assigns meaning to objects in ways that best model reality (Balbi, 2008); even when no empirical evidence exist. The constructivist view suggests that the objects, attributes, and attributes within the mind are in flux, and that the representation of the real world held by a specific individual could be significantly different i) at different points in the individual’s life, and ii) from reality itself. This view is in conflict to the ‘associationist’ view of learning which states that the mind does not actively create objects but passively gathers objects from the environment due to empirical reasoning. Structural learning theory is a prescriptive model that implies that learners do you follow a predefined pattern in hell they determine and learn from the environment. As such Piaget suggested that learners are both i) dynamic in their understanding of the world, yet ii) do follow specific stages of child development that occur as a result of social and physical development. Piaget defined four primary stages: Sensorimotor (Birth to age 2), pre-operational (age 2 just 7), concrete operational (age 7 to 11), and formal operational (aged 11 upwards).

1) The Sensorimotor stage - is primarily linked to a child appreciating difference between themselves and their environment. Within this stage children interact with and experiment within the world; i.e. in order to appreciate basic interaction skills - e.g. reflex acts, primary reactions (e.g. wiggling fingers, kicking legs, etc), secondary reactions (e.g. object interaction), coordinating schemers (purpose driven interaction), Tertiary reactions (context driven strategy), and symbolic thought (e.g. visualisation of objects and object attributes that they cannot see).

2) The Pre-operational stage - occurs between the ages of approximately two and seven years old and relates to the child building up a symbolic (yet not logical) appreciation of existence. A child is aware of specific ideas, and is able to mentally represent events and objects, i.e., undertake the semiosis process, but is not able to use logic in order to explain this function. Key features at this stage include: Centration, where the child is learning to either focus on one aspect of the situation or multiple aspects of the situation at one time; Egocentrism, which relates to the child's ability to see the situation from another person's point of view; Play (including symbolic representation and play), where a child learns to play with another child (relating to a combine narrative), both communicating their thinking with others, and/or using words or objects that representing something else; Animism, where a teddy bear or toy can have human feelings and intentions. Piaget identified at this stage that children are aware that the world is alive, conscious, and has purpose; however, the level of animism develops over time.

3) The concrete operational thinking stage - (commonly experienced between 7 to 11 years) - is characterised by the inclusion of logical reasoning. Ideas, such as the conservation of mass, are increasingly appreciated by children; as experience and increased ability to critically reason suggests that the quantity of liquid does not change if you pour water from a tall thin glass too sure fat glass (and vice versa). Moreover, an items appearance can change without changing its identity, e.g., a cake in the shape open football is not something to be kicked just because it looks like a ball. Piaget considered the concrete stage major turning points in child development as it allowed children to mature their appreciation of the world through logical reasoning (i.e., the development of rules, norms, and schemas). Within the concrete operational thinking stage children also conduct i) object classification, i.e., the linking of objects within mental ontologies, and ii) critical evaluation.

4) The formal operational stage - is the 4th and final stage of Piaget’s theory of human cognitive development. The formal operational stage occurs pre-teen when children are able to logically consider the truth about the claims being made. Throughout the formal stage, which Piaget claims continues into adulthood, individuals are able i) hypothesise what should occur from previous experience (or logical reasoning), and then ii) systematically test whether the hypothesis is true or not. Within the formal operational stage individuals can think in an abstract way, which allows the use of abstract modelling or structured mathematical reasoning. Within the formal operational model stage individuals are also able to discuss and consider reasons that are contrary to fact. For example, individuals in this category would be able to consider, via logical reasoning, what would happen if........ The ability to consider alternatives perspectives is critical to systems level thinking, however development of formal operational stage skills (e.g., deductive logic, abstract thinking, problem solving, hypothetical deductive reasoning) or all improved by consistent application and practise.

Due to significant long standing impact and contribution of Jean Piaget's theory of cognitive development in the field of education, numerous critics have argued against specific points. For example: that Piaget's Theory underestimates the competence of children, including language (e.g., Siegel et al., 1978), contextual variables (e.g., Rose and Blank, 1974), memory requirements (e.g., Bryant and Trabasso, 1971), materials (e.g., Levin et al., 1978), the nature of the task (e.g., Baillargeon, 1987), number of objects present (e.g., Gelman, 1972), the type of questions asked and responses required (e.g., Winer et al, 1988); Piaget established 'age' norms that are not confirmed by data (Chapman, 1988a, Smith, 1991); that his earlier books (Piaget, 1923; 1924) characterise development negatively, with pre-school children often described as illogical and/or incompetent (Donaldson, 1987; Siegal, 1991); that Piaget neglects the role of social factors in development (Winegar & Valsiner, 1992, Forman, 1992), which Murray (1983) summarised well stating "the [Piagetian] epistemic subject has no social class, sex, nationality, culture, or personality" (p. 231); that Piaget describes but does not explain (Boden, 1979; Flanagan, 1992); that Piaget Theory is paradoxical because it assesses thinking through clinical methods and verbal techniques, yet does not consider the impact of language in the model (Braine, 1959; Siegel and Hodkin, 1982); that Piaget ignores post adolescent cognitive development (Alexander & Langer, 1990), and finally that Piaget theory uses inappropriate/vague logical structures, such as the eight Piagetian groups of concrete options (Bruner, 1992; Halford, 1992).

The work of Piaget suggest that individuals are constantly constructively forming models of the real world; suggesting that two individuals will have distinctly different understanding of what objects, attributes, and values exist in the world. Despite this constructivist perspective, key learning can be defined into sequential steps, which allow individuals to work towards i) a more complete understanding of the real world, and ii) development of critical skills to support abstract logical reasoning. Accordingly it is critical to ensure that any systems model is i) able to support a constructive understanding of reality, ii) to allows individuals to work logically work toward predefined goals, iii) to support skill development, and iv) to support some critical reasoning.

2.5.6. The VARK Learning Model

The VARK model, first used by Fleming (Fleming and Mills, 1991), considers how information is processed from Visual, Auditory, Reading/writing, and Kinaesthetic learning styles. The simple model infers that learners have a preferred learning modality – i.e., either visual learning (pictures, movies, diagrams), auditory learning (music, discussion, lectures), reading and writing (making lists, reading textbooks, taking notes), or kinaesthetic learning (movements, experiments, hands on activities). By diagnosing somebody as a specific type of learner, educators can then develop interventions and/or learning material in a form that best aligns with their learning preferences. Similar to 4Mat data collection approaches include: Surveys and Questionnaires; Observations; Interviews; or Self-assessment.

Evidence suggests, however, that this individuals do not have fixed and unchanging learning styles (Fitkov-Norris, 2015), and that the VARK learning model: is over simplified, which masks complexity learning and binding; dismisses critically consider the impact of learning disabilities, lacks scientific validation and/or empirical support; can enforce stereotyping and bias; is inconsistent in outcome; can easily be misinterpreted by educators (Pasher et. al. 2009; Felder, 2020), and relies to much on commercialised testing instruments.

Many educators believe that learners will assimilate more content, and gain a more complete view of reality, if learning material is delivered in the form that aligns with their student learning preference. Type one learners (i.e. able bodied learners), however, swich unconsciously between, and combine information from, the four VARK modalities. Although the learner has a more pleasurable experience if learning material is aligned with their preferences, the level of learning is only marginally improved if preference channels are used; since sensory processing is largely consistent for all able-bodied humans (Smythies 1994, p. 54). Although learning material is assimilated from disparate modalities, different sensorial information is initially processed in different parts of the brain, resulting in certain media being deemed more enjoyable by learners. The learner's final perception of reality is an assimilation of all media (Ghinea et al., 2014); with the brain integrating sensory fragments in a process called binding (Damasio 1989, p. 29). Based on the work of Myer (2003), Marious and Ivanoff (2005), and Fadel and Lemke (2008), Figure 2.8 expresses the schema of thinking processes, to highlight the importance of semantic knowledge – i.e., objective facts, ideas and concepts – and episodic knowledge – i.e., the recall of subjective life experiences – impacting attention focus, the binding process, and future object selection mechanisms.

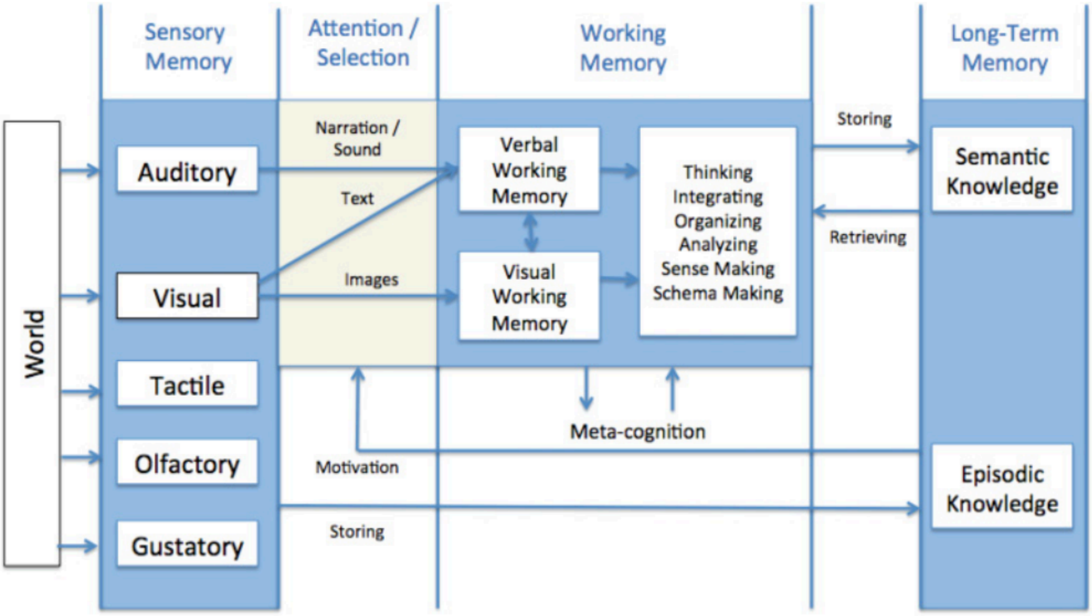


Figure 2.8. Schema of thinking (adapted from Ghinea et al., 2014).

The learner might prefer to assimilate information from a specific input because the learner knows that focusing attention on specific input makes the experience more subjectively enjoyable (i.e., the Hedonic motivation). For example, the Dan Le Noir restaurant in London, which literally translates as 'In the dark', allows diners to experience a pitch-black gastronomic experience. The darkness forces learners to *'re-evaluate the perception of taste by reawakening senses overwhelmed by the omni-presence of sight'*. If modalities are not removed, however, research has shown that sensory inputs combine to influence thinking and sense-making. By forcibly limiting the input channels the 'Dan Le Noir' experience is purposefully managing sensory focus. 'Type 2 learners' possess a physical or learning disabilities (e.g., blindness or hearing loss) that impacts or prevents the assimilation of information from specific input channels; causing significant variance in access to information when learning material is not delivered using input preferences. In such cases learning material must be specifically adapted to facilitate access to material using simulation channels that are available to the individual.

Gulliver and Ghinea (2003), for example, analysed how individuals with different hearing levels, and types of deafness, assimilated information from multimedia video clips. Results show that level of hearing had a significant effect on the participants' ability to assimilate information. Deaf individuals, however, needed to focus on the captions if they wanted to appreciate the context of the video. Results showed that post-lingual mild and moderately deaf participants still depend on the audio feed for provision of context and had not adapted to using subtitles. Hearing loss over time often results in individuals assimilating less information than pre-ligualy deaf participants, as they had not learnt to change their information assimilation and attention focus, resulting in a reduced (type 2) learner experience.

The research related to the VARK model highlights that assimilation of information is impacted by perception and biological limitations - i.e. the type two experience. If someone does not physically perceive the information, then will not be able to incorporate this information in the reasoning. Any final model should include consideration of the impact of perception and physical limitations on information assimilation.

2.4.7. Felder-Silver Learning Style Model

The Felder-Silverman Learning Style Model, defined by Richard Felder and Linda Silverman (1988), focuses on definition of different learning styles and preferences. The research was untaken to categorise different engineering students. The original Felder-Silverman model defined five dimensions that are used to determine learning styles. These dimensions, - i.e., active v reflective, sensing v intuitive, visual v verbal, inductive v deductive, and sequential v global - should not be seen as dichotomous categories but as a continuum of preference. The inductive v deductive dimension was removed in 2002, resulting in the dimensions presented in figure 2.9.

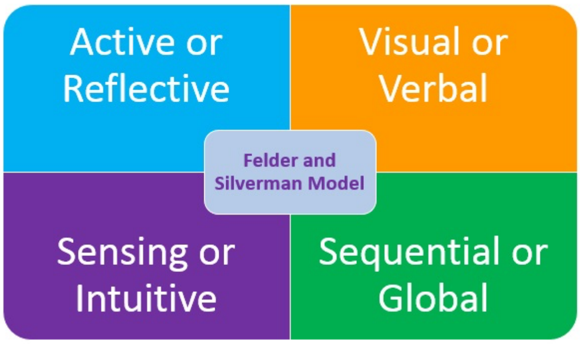


Figure 2.9. The Felder-Silverman Learning Style Model (adapted from Felder, 2002).

The simplified model aims to classify individuals based on the following dimensions:

- Sensing versus intuitive, which determines how you prefer to perceive or assimilate information.

- Visual versus verbal, which relates to how you prefer information to be presented to you as a learner.
- Active versus reflective, which determines how you prefer to process information.
- And finally sequential versus global, which relates to determining how you prefer to organise add categorise this information.

As with many of these models the Felder / Silverman model focuses on trying to understand the mechanism of learning for each individual, but has limited appreciation in consideration of the context of learning; assuming that the same learner will prefer the same type of input at all time, and will process information in the same way irrespective of the learning context. Moreover, the Felder / Silverman learning model defines learning preferences for individuals that are more closely linked to each of the extremes, yet due to the continuing nature of each dimension it is considerably likely that several dimensions will not express a preference and therefore information and advice is unhelpful.

The Felder-Silverman Learning Style Model has been accused of having numerous flaws. For example, instead of seeing options as a continuum between extremes, users erroneously assume that selection is dichotomous. Felder and Spurlin (2005) contended that this misconception is a common amongst educators, however did nothing to alleviate this concern in recent versions of the model. Moreover, the validity and reliability of the Felder-Silverman Learning Style Model is problematic, due to doubts about the construct (Van Zwanenberg et al., 2000), resulting in low model reliability.

Felder (1993) discussed the relevance of specific learning styles to the teaching of science to adults. After examining four different models – the Myers-Briggs Type Indicator, Kolb's Learning Style Inventory, Herrmann's Brain Dominance Instrument and his own Felder-Silverman instrument – Felder concluded (1996, 23): 'Which model educators choose is almost immaterial, since the instructional approaches that teach around the cycle for each of the models are essentially identical'. This view, however, is strongly criticised by Coffied et all (2004), who i) believe it matters which model is used, and ii) has serious reservations about the learning cycle.

It is clear, as with all learning personality theories, that dependence on a specific learner preference / factor is limiting to the learner ability to develop new patterns. The Felder-Silverman learning style model independent drivers, and highlighted that it is critical for the final systems model to support multiple overlapping drivers, and a mechanism to identify the best behaviour in context of the current problem scenario.

2.4.8. Kurt Lewin's Field Theory of Learning

Kurt Lewin (1890-1947) is recognised as the founder of social psychology, yet is known in business for his work on change management. Additional contributions to knowledge include the invention of action research, development of experience-based and field theories of learning (or topological psychology as he also called it), field force analytics, and group communication models. Lewin believed that *"Learning is a process of perceptual organisation or reorganisation of one's life space involving insight and emphasis on behaviour and motivation in learning".* To consider the relationship or context and behaviour, Lewin conducted several studies to understand child behaviour; reasoning that human behaviour was the result of interplay of both physical and social situations, claiming that behaviour (B) is the result of the function of the person (P) and the environment (E). Lewin stated that the individual's behaviour is linked to a 'life-space' (Burnes and Cooke, 2013), and that an individual's behaviour is not just a product of past events or future expectation alone, but a function of the interaction between the individual and their contextual environment (i.e., "the field") (Marrow, 1977). In Lewin's Field theory of learning, see figure 2.10, he describes how an individual moves through their life space, which contains himself, the goals he is seeking to obtain (termed the positive violence), the goals he is trying to avoid (termed the Negative valence), and the barriers that restrict the individual's movement (see figure 2.10). Lewin implies that life space has a discreet boundary and can be separated into various regions, and that individual regions will be linked with different goals, and valences. Existence of a goal within the life-space creates an internal tension (a dissonance) which drives the person towards actions that aim to achieve the desired outcome. Although barriers exist, which can act to physically or psychological prevent people from reaching goals, if achieved then the person returns to a rest state (a state of response) until a new goal activates dissonance.

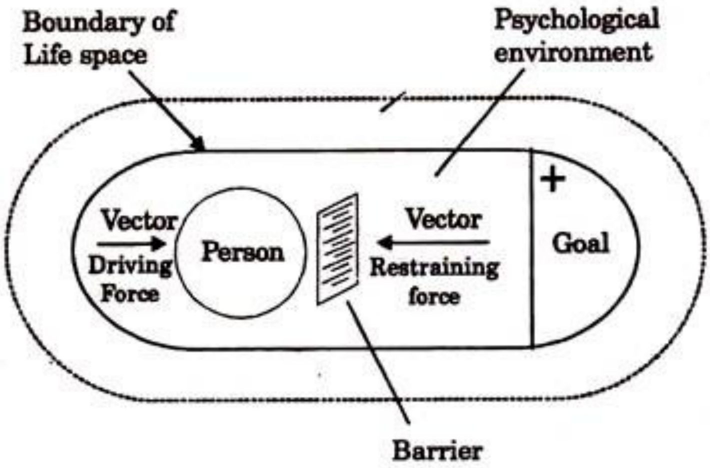


Figure 2.10. Lewin's Field Theory of Learning (adapted from Lewin, 1937).

Lewin's theory considers learning to be either: i) a change in cognitive structures (knowledge), ii) a change in motivation, i.e., valence or values, iii) a change in skills and/or abilities (processes), iv) or a change in group belonging (social influence). These changes result in new insights replacing old ones, which impact the life-space and/or the persons awareness of reality. Changes in awareness of reality can result in formation of new goals and/or impact the person's feeling of dissonance, which in turn drives (i.e., valence) towards (positive) or away from (negative) specific goals being achieved.

Although Lewin's Field Theory of learning has been widely praised for its contributions to the understanding social behaviour and group dynamics, it is worth noting, however, that the field of psychology has evolved significantly since the mid-20th century. Critics of Lewin's Field Theory of Learning argued that the concepts are not always well defined, making it particularly difficult to apply in practical situations. London (1944, p. 289), for example, arguing that not only was it *'impossible'* to use [Lewinian] topology as a method of mapping out the life space of human beings, but '*that in any case, Lewin's topology is not the topology of mathematics'*; suggesting that Lewinian topology cannot be used in the way that Lewin desired. Although highlighting the importance of context, the framework ironically lacks specificity; placing instead too much emphasis on environmental factors; i.e., ignoring individual, personal, cognitive, and emotional factors.

Despite the criticisms, Lewin's field theory of learning highlights that learners are driven by things differently in different learning spaces, and that a teacher must appreciate that a learner that struggles in one space might excel in another area / situation. Moreover, that management of goals and/or barriers is essential to effective motivation learner. Reaching a goal constitutes a success, however goals need to be defined at an appropriate level, or the learning is likely to never achieve success and dissonance is likely to be replaced by despair. If the goal is perceived as unobtainable, then the learner will only experience the stress of dissonance and will likely become disillusioned that success is not possible. Similarly, management of barriers is critical to ensure that success is managed, i.e., that success without effort is not encouraged. Lewin, for example, highlighted that a student who wishes to obtain a distinction in an examination might see cheating as the most efficient means to achieving the goal; unless appropriate barriers are put in place to limit the consequences of such actions (e.g., expulsion). If, however, goals and barriers can be controlled the Lewin's theory of learning provides an accurate representation of the learning experience.

Accordingly, it is critical that a final system model that considers the impact of context on behaviour; supporting i) the consideration of goals, and the impact of this on behaviour outcomes, and ii) multiple possible behaviours in order to support consideration of internal dissonance and learning.

2.4.9. Robert Kegan's Learning Model of the Mind

If you ask a child about the concept of 'being a grown up' it is normally quite clear and distinct. Once biological changes have occurred, around the age of 18, the person (as suggested by Piaget) is no-longer a child. Children see adults as able to understand and influence the world around them. For anyone with teenage children, however, it is not a surprise that an increasing quantity of research suggests that although physical development may be complete at 18, cognitive development continues throughout life.

Robert Kegan – a educational psychologist – showed that to be a 'fully-fledged adult' individuals should go through 5 distinct development stages, however only about 1% of individuals actually rise to stage 5. Stages include: 1) impulsive mind (early childhood); 2) imperial mind (adolescence – representing approximately 6% of the adult population); 3) socialise mind (representing approximately 58% of the adult population); self-authoring mind (representing approximately 35% of the adult population); and self-transforming mind (representing only 1% of the adult population).

Robert Kegan (and his team) explore how well individuals reconcile conflicting beliefs, values, and identities into a more cohesive and integrated sense of self. To capture the data required to categorise a participant, Robert Kegan conducted detailed interviews, focusing on i) participant's perspectives, beliefs, values, and ii) the ways in which they understand themselves and the world. Kegan's framework uses the complexity of an individual's thought processes to differentiate cognitive development. Accordingly, open-ended and exploratory interviews were used, allowing Keegan to delve into the depth of an individual's cognitive structures. By assessing the subject's ability to handle ambiguity, Kegan was able to consider multiple perspectives, and engage in abstract and nuanced thinking, which helped Keegan to characterise the individual's current stage of cognitive development. Critics complained, however, that i) interview mechanisms were overly time consuming, and ii) that the resultant conclusions over simplified the variation that exists in the adult population (Helsing, 2023). In response to criticism, Lisa Lahey developed a specific interview protocol - known as the Subject-Object Interview (SOI) as a means of assessing a person's "unselfconscious epistemology or principles of meaning-coherence". The SOI explores the subject's ability to differentiate between themselves and their thoughts, beliefs, and emotions, however the interview still takes 75 minutes to complete (Lahey et al., 2011).

Kegan (1982), similar to Piaget, described new-born infants (level 0 - Instinctive plateau) as "living in an objectless world, a world in which everything sensed is taken to be an extension of the infant" (p. 78). A new-born child possesses innate norms, such as pre-attentive visual processing, but it takes a considerable time to distinguish between real-world objects, and between objects and self. This distinction is essential to facilitate purposeful interaction with the world, and iterative development of object definitions is therefore critical.

By about 18 months (or two years) an infant has determined their own body (e.g., movement and reflexes), and the shape of basic world objects, and has determined the essential constructs that exist; allowing interaction between the world and self to occur (level 1 - Impulsive mind). Between the ages of two and approximately six years old the infant learns from impulse driven interaction, mimicking, and experimentation. There is minimal separation in the child's world model between imagination and reality. Due to a naïve ontology of the world, entity categories and properties are not fixed. The infant therefore has a rough appreciation of how things work, but the function, properties, dependencies, and scope of entity influence is not clear. Kegan defined level 1 as having an atomistic perspective view of the world, which is unclear and flexible.

Over time, as reality and the edges of impossible are increasingly defined, the model of the world - e.g., object classifications - becomes more rigid, and the existence, importance, and use of object attributes and properties become concrete. Kegan states that within the imperial learning plateau (level 2 - imperial mind) the child becomes increasingly aware of others as the providers of their needs. Although they care about others, doing the 'right thing' is arguably driven by a fear of personal consequences, not because they appreciate the value of doing the right thing ; e.g., "I do not steal because I might get caught – and that would have a big impact on me". Accordingly, individuals (mainly children) in this plateau - who are often driven by satisfying their own needs, interests, and desires - unthinkingly follow rules and beliefs. Rules are followed not because they believe them to be true or worthy, but because of the self-driven rewards that will be gained if they do (and punishments if they don't). Kegan defined individuals in level 2 as having a 'concrete' view of the world, which is believed to be true for everyone.

As individuals develop, they start to challenge the ideas, rules, and beliefs they were taught with the experiences of world around then. In plateau 3 (socialised mind) individuals start to appreciate the importance of how others experience us, and individuals will increasingly feel pressure to change their beliefs, behaviour, and actions to positively influence the views of others – e.g., 'People say I look stupid / fat / old wearing those clothes.' Or 'I can't say 'that' to them - it would offend them'. Within this plateau individuals no longer see others as a means to an end but are willing to reshape themselves to fit with the world suggested by others, i.e., taking ownership of the beliefs of others yet potentially failing to critically question how beliefs were formed or developed. An individual in this plateau will most likely only appreciate that he/she is good at something if told by others and/or if success is ratified as part of some collective formal test, grading structure, or qualification; and the certificate will be of more value to the student than the learning. Moreover, individuals in this groups start to appreciate how actions can have consequences to the other person. Kegan suggested that approximately 58% (the majority) of adults live out their life with a socialised mind (see figure 2.10). Kegan defined individuals in level 3 to have a cross / trans-categorical perspective of the world, which aligns to traditionalists views, i.e., where people do not question the cultural and religious values contained within their environment.

“Blind belief in authority is the greatest enemy of truth” - Albert Einstein

Those who push beyond level 3 increasingly appreciate that they have an identity that is i) self-formed, and ii) distinct from the group (level 4 – a self-authoring mind). Their thoughts, feeling, and beliefs may align to the views of others, however these views should be justified independently from the standards and expectations of others. The ability to be in a group, yet distinct in your own identity, allows individuals to make independent decisions (see figure 2.11). This level is distinctly different to the stages considered by Piaget.

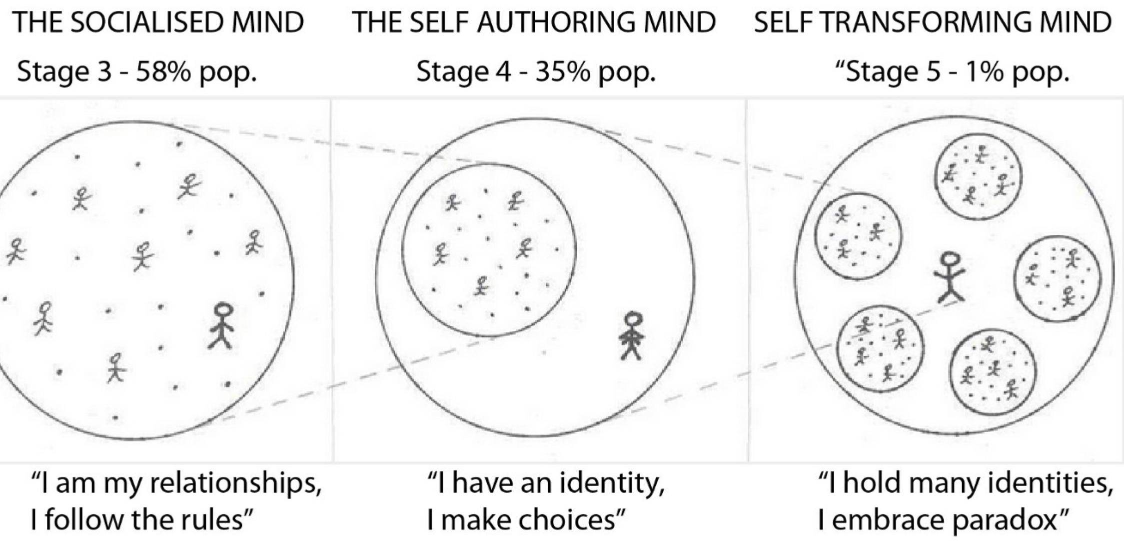


Figure 2.11. Constructive Development Theory (adapted from Kegan, 1998).

Individuals at level 4 of Kegan’s model become autonomous within the system of the environment, which allows individuals to appreciate that others, although not having the same ways of thinking, beliefs, or behaviour, should be respected for their independence. A person at this plateau can safely question the expectation and values of others, as it allows an independent view of the world. Kegan defines level 4 as “system based” (or complex). When you hold the view that each person is a separate system, with a fully independent perspective and view of the world, then multiple perspectives of the same world can co-exist. Moreover, the other person’s understanding of the world has been constructively defined from their perspective, so, although maybe different, has equal value to appreciation the holist ‘reality’. It is acceptable that different perspectives either align, complement, or disagree with one another. At level 4 subjectivity is openly encouraged, and self-critical reasoning is used to identify whether a single truth is even possible is some areas. The self-authoring mind plateau aligns to the modernism perspective, i.e., where rationality and logical reasoning is used to determine knowledge and truth – and multiple perspectives may hold different aspects of that truth. Kegan suggested that approximately 35% of the adult population develop a fully functioning self-authored mind (see figure 2.11). Interestingly Kegan is very clear that only once someone had obtained a fully self-authoring mind can they fully appreciate the complexity of systems dynamics.

The 5th and final plateau (level 5 – the self-transforming mind) defined by Kegan is termed 'the interconnected mind'. Individuals who are consistently at this plateau are able to maintain their own core identity, whilst being able to adapt and reinvent their identity in different situations to fit multiple changing environments. Ken Wilber (2007) suggested that, as the ego of the individual shrinks the individual's awareness of the whole increases. The individual at this plateau can place their individual concerns and needs aside to fully appreciate the multiple and co-existing perspectives of others. They can appreciate the interaction, alignment, and conflict between multiple perspectives, and are able to understand a problem from multiple perspectives at the same time – allowing a solution to be considered. Kegan stated that most people think themselves to be at a higher stage than they are, yet only 1% of people are truly able to fully develop the self-transforming mind; allowing them to embrace the paradox of multiple perspectives.

Kegan's work has received a mix of praise and criticism. Kegan's work is very hard to read, and critics argue that there is: limited empirical validity to validate the 5 levels; an over emphasis on cognitive development and limited consideration of cultural and environmental factors (Wilber, 2007); overly long SOI interviews; and confusion concerning the higher stage definitions, which result in limited practical application. Moreover, the model is (in part) similar to other societal development model, for example: Wilber's (2007) integral spectrum of consciousness, which uses a very similar categorisation of levels to Kegan, yet claims the existence of additional higher cognitive and spiritual levels; the spiral dynamics framework of Beck and Cohen (1996), which uses eight stages describing linked and dependent worldviews; Kohlberg's (1968) scale of moral development, which uses six stages to categorise individual moral complexity; and Loevinger's (1976) ego development model, which uses a dozen stages to describe human behavioural development.

Robert Kegan is specifically considered in this research because his work highlights two key findings of relevance to assimilation of complex systems thinking: i) that approximately 50 to 60% of adult individuals are at level 3 (the socialised mind) or below; and ii) that a large proportion of individuals aged 18 to 21 are still developing their mental complexity – with only limited numbers having developed, at that stage in their cognitive development journey, a self-authoring mind. We can infer from this that at least 50% of university students will be at level 3, which means that a considerable proportion of MM258 students will not find "systems based" (or complex) thinking natural.

2.4.10. Conclusion

In Kolb's learning model (see section 2.4.1) we showed that learning is not a fixed process but involves reflection and iteration, however difference exists in the focus of different learners, which implies that during iterations people assimilate different information, i.e., depending on whether they are accommodating, diverging, converging, or a simulating in nature. The Gregorc learning model, presented in section 2.4.2, highlights that some learning is logical and slow (required to provide a filly accurate solution outcome), some learning is random yet quick. Accordingly, it's essential that any learning model considers both fast (logical) and slow (reactive) learning approaches. Moreover, consideration of different types of learning (and the link to biology) needs to be considered; as suggested by the HDBI Instrument (see section 2.4.3). Consideration of different learning categories is extended in consideration of the 4MAT learning model (see section 2.4.4), which implies that different people place a preference of focus on why something happens (imaginative learners), what happens (analytical learners), how something happens (common sense), or consideration of what might be (dynamic learners). This preference for consideration of conceptual, formal, or technical norms implies there are distinct difference in the focus and motivation of different learners. Piaget's learning model (see section 2.4.5) highlights the fact that learning is a process that is in constant flux over the lifetime of the learner, however the VARK and Felder-Silverman Learning Style Models (see section 2.4.6 and 2.4.7 respectively) shows that i) information sources and styles are often preferred by individuals (e.g. visual or verbal), ii) that information from multiple sources is combined together in the mind – due to the process of binding, however that iii) assimilation of information can be impacted by physical perception and biological limitations that occur over time. Lewin's model (see section 2.4.8) highlights that individuals are driven by goals, yet that the information gained from the world required to satisfy the goal, will consist of a range of different abstractions, e.g., motivation, knowledge, skills. As such the learners focus will be different because of context and social influences. The final model considered related to Robert Kegan’s learning model of the mind (see section 2.4.9). Kegan stated that learners each possessed a separate model of the world. In level 1 the learner determines the objects, attributes and entities that exist within the world. In level 2 the learner interacts with the objects, to understand the behaviour and property functions of the objects; allowing the development of automatic responses and heuristics to support reduction in cognitive processing. In Level 3 learners learn how to interact with others, appreciating the impact that your actions and behaviours have on others. Interestingly, however, only at level 4 of Kegan’s model is an individual able to fully appreciate complex systems thinking, i.e., where the learner is able to perceive different people (along with their world views) as separate interacting systems.

Most models discussed in section 2.4 focus on and/or represent one aspect of learning, however by consider multiple models we can see that the learning process is a complex issue that requires consideration of many issues. In context of MM258, the fact that i) Kegan implied a requirement for individuals to be at level 4 before effective systems thinking was possible, and ii) that the majority of individuals who do get to level 4 only get to level four later in their life (in their 30s and 40s), raises two significant issues that need to be addressed. If a reasonable proportion of student completing the MM258 module are at Kegan's Level 3: i) is it possible for them to assimilate the IS concepts and models being considered in the MM258 module? and ii) How can we support teaching of complex information systems concepts to such students?

2.5. Problems Definition / Aim and Objectives

Kegan’s five step model highlights a distinct problem to the teaching complex systems to 18-year-old pre-experience undergraduate students; and that students at level 3 may have limited experience and/or cognitive structures that Kegan’s stated as being essential to consideration of systems thinking. Accordingly, two research questions (i.e., RQ1 and RQ2) were developed:

- Research Question 1 (RQ1) - “Do MM258 students understand the systems models currently being taught to them?”
- Research Questions 2 (RQ2) - “Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?”

Accordingly, this thesis aims to answer these two questions. To achieve this, the following objectives were defined:

- Conduct a systematic literature review to understand current thinking in the area of systems, education, and information systems education.
- Design, develop, and undertake data collection to collect data concerning pre-experience management students understanding of several current information systems models.
- Analyse collected data to i) evaluate what students perceive when considering information system models, and ii) determine a kernel theory (that students understand) that can be used as the base for development of a single holistic information systems model.
- Iteratively develop a unified model, which is i) simple enough to be used with UG teaching, ii) structured enough to incorporate a range of key literature, and iii) extensible to allow future development.

2.6. Conclusion

Implications from Kegans' five steps key model suggests i) that appreciation of complex system and system-of-systems requires a self-authored mind, yet ii) that the majority of 18-20 pre-experience undergraduates will not possess this self-authoring mind (with only approximately 35% of adults developing this way of thinking). I believe that only when a student is able to appreciate that they themselves are systems - i.e., a holon constructed from whole parts, dependent on the outcome of other systems, and interacting as parts in multiple larger systems - can they fully appreciate the full complexity of content being presented in the MM258 module. Only when i) students are able to appreciate that their view of the world is most likely very different from the views of others, ii) that this difference in world view is due to upbringing, culture and experiences, and iii) that decisions that you make is influenced by the impact of learnt influences but will (in turn) influence other system, can the student truly see the significance and impact that they have in the world.

In this chapter we have completed the first objective, i.e., to conduct a systematic literature review to understand current thinking in system, education, and information systems education. In the next chapter we will consider the research methodology to support completion of objectives 2 to 4.

Chapter 3
Consideration of Research Methodology and Methods

3.1. Introduction

Within this chapter we aim to systematically consider the research paradigms, methods, and techniques that are needed in order to address the two research questions, i.e., Do MM258 students understand the systems models currently being taught to them? Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?

To consider which paradigm, methods, and techniques are relevant to this research, the current chapter will start by highlighting the Ontological, Epistemological, Methodological, and Axiological assumptions held when applying a range of research paradigms. Subsequently we will then, using Saunders onion as a support structure, highlight, in context of objective outcomes, what methods and techniques are best applied to achieve specific objective goals.

3.2. Understanding Research Assumptions

Within the domain of Information Systems, research focused on the consideration of four sequential assumptions, which initially shape the assimilation / formation of the research outcome; i.e., ontological, epistemological, axiological, and methodological assumptions.
Ontology assumptions relates to a researcher's perspective concerning 'the study of being' (Crotty, 1998) – i.e., the nature of existence. Ontological assumptions relate to what exists in the world, and considers from where a researcher can acquire knowledge? Ontology primarily relates to whether a real (single physical / measurable) reality exists – understood using naïve, structured, or critical realisms – or whether multiple relativism (subjective, mental) realities exist as a result of stakeholder perception – understood by applying bounded relativism or relativism.

Epistemological assumptions relate to the nature of knowledge and exists when the method of capture and analysis of knowledge impacts how we know what we know. Objectivism suggests that objective knowledge is linked to a physical object, and that knowledge is independent to the focus of research. Subjectivism suggests that knowledge is subjective and linked to the subject of study (not the object of study). Subjective knowledge is formed in the mind and is contextually influenced by the context of study. If a researcher holds an objectivist perspective, then they believe that there is a single truth – i.e., an absolute outcome that can be hypothesised and/or tested. An objectivist research outcome is true for all stakeholders – e.g., gravity. If a researcher holds a subjectivist perspective, then the research finding our subject to the perspective of the stakeholder, and the context of measurement. A subjectivist research outcome is no longer absolute for all but must be interpreted in context of the problem scope and stakeholder perspectives.

Axiological assumptions relate to how valuable specific problem constructs and / or knowledge is to the research outcome; impacted by the problem aim and research domain.
The fourth, and final, assumption being discussed here, relates to the Methodological assumption, which includes consideration of the processes involved in the design, capture, and analysis of data; via application or relevant research methods to achieve the desired research outcome (Crotty, 1998). In appropriate application of methods, incorrect sampling of populations, or incorrect analysis of data all impact a researcher's ultimate ability to accurately represent the findings in data.

3.3. Saunder's Onion

The Saunders research onion framework (Saunders et al., 2013) can be used to support consideration of methodological options. To select the most effective and appropriate research paradigm, methodology, and methods, it is essential to appreciate the inherent assumptions expressed as this impacts the research choices, and the impact that such assumptions have on the research outcome. Six concentric circles were navigated, from largest to the core, to assist in the systematic consideration, selection, and alignment of relevant research philosophies, approaches, methodological choices, strategies, time horizon, and research techniques and procedures.

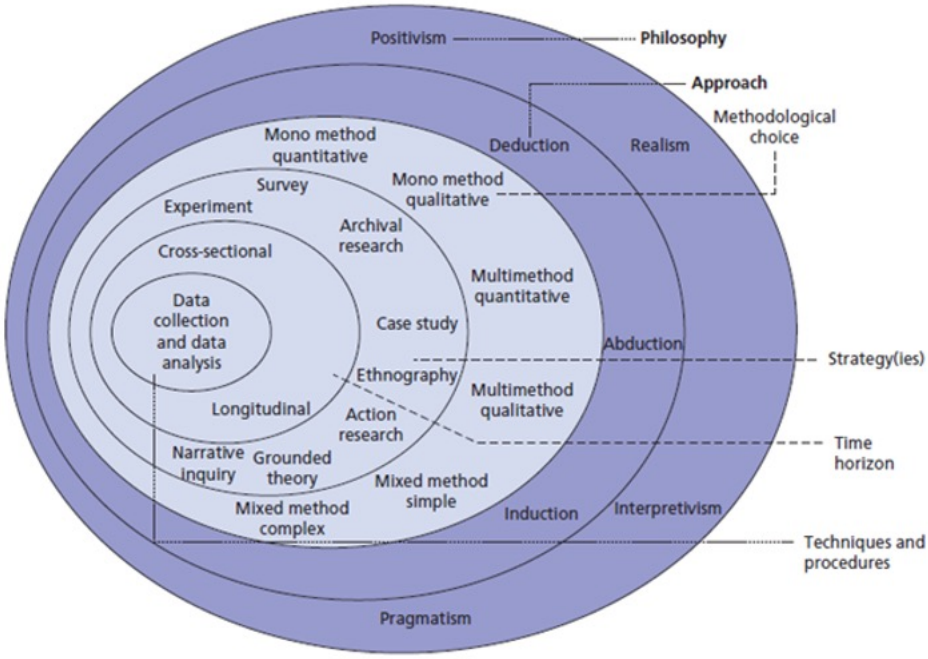


Figure 3.1. The Research Onion (adapted from Saunders et al., 2003).

3.3.1. Research Philosophies

Filstead (1979) defined a paradigm as 'a set of interconnected assumptions about the social world that offers a philosophical and theoretical framework for the structured study of that world'. Saunders at al. (2003) stated that 'The research paradigm is viewed as a set of beliefs or perspectives concerning the process of gathering, analysing, and using data related to a particular problem'. The research philosophy therefore reflects a researcher's perspective concerning the development of knowledge (Bajpai, 2011). Since development of knowledge is influenced by a researcher's view of the world, it is essential to justify and align, in context of the problem, the process used to select the research approach, strategy, methodology, and methods (Saunders et al., 2003). Key researcher philosophy assumptions in the field of information systems relate to i) ontology, which concerns the nature of the work and the study of existence, ii) epistemology, which relates to the relations that a researcher has with this reality, and iii) methodology assumption, which concerns the selection of the appropriate research methodology. Research philosophies (e.g., positivism, interpretivism, pragmatism, design science) guide the development of the problem definition, data collection, and interpretation of data and results (Guba and Lincoln, 1994); and impacts both ontological and epistemological concerns.

Positivism makes the assumption that the world can be objectively defined. Research is positivist when it measures of causal relationships, for example validation of a hypothesis. Positivism methods allow numerical significance to be determined, and therefore relies on the use of quantitative data collection methods, large sample sets, and appropriate statistical modelling and analysis. The positivism paradigm requires explicit, repeatable, and accurate measurement of variables in order to support the validation of defined factor relationships. Positivist research can show that something is numerically significant, however numerical reasoning alone does not facilitate a researcher in interpreting how the significance impacts subjective, individual, and hermeneutic aspects of a social phenomenon (Orlikowski and Baroudi, 1991). Positivism can support prediction; however, it does not always facilitate understanding – for example: Knowing that sales fall in a specific month can support production planning but knowing that something happens is not the same as understanding why it happens. Accordingly, the social scientist must collect facts and data describing not only the projected, publicly observable aspects of human behaviour, but also the subjective meaning for the human subjects themselves (Lee and Baskerville, 2003).

Interpretivism can be applied to support the interpretation of how significance impacts subjective, individual, and/or hermeneutic aspects of a social phenomenon. Interpretivism assumes that the world is subjective, and therefore elaborative consideration of aspects of human behaviour is critical to understand the existence of significant factors; since it allows consideration of the frame of reference (Collins and Hussey, 2013). Interpretivism allows a researcher to understand differences amongst specific social actors (Saunders et al. 2003) by considering contextual perception and meaning. Interpretivist approaches rely on naturalistic data collection, such as interviews and observations, to allow the contextual meanings contained in qualitative data to be more fully understood. Use of interpretivist approaches allows collaboration and elaboration of factors that exist within a specific context and/or domain yet does not allow a researcher to explicitly define the generic level of significance.

Realism takes the view that things that can be known, perceived, and/or exist in nature are independent of the person thinking about or perceiving them. Realists believe that what we know and believe is only an approximation of reality, but that our understanding of reality is developed because of knowledge creation, and that subjectivism is caused by our interpretation of reality, not a part of it. Use of a realism alone as a research philosophy assumes that one truth exists, yet this arguably contradicts system thinking that assumes that a system outcome can be perceived in multiple ways depending on the stakeholder perspective.

Pragmatism is a reasonable and logical way of doing things and/or of thinking about problems that is based on dealing with specific situations instead of on ideas and theories. The right person for the job will balance vision with pragmatism. Although interpretative findings may be compared across the realist paradigm, there is considerable benefit of combining both positivism and interpretation methods pragmatically to support elaboration of a problem and/or validation of significant factors. Use of pragmatism as a research philosophy facilitates the strategic use of mixed methods research, i.e., the simple and complex combing use of positivist (Quants) and interpretative (Quals) methods, to support a researcher's understanding of the research problem.

Design Science was first introduced by Fuller (1957) as a systematic form/structure to effective design. Herbert Simon (1969), however, was the first person to make the explicit distinction between design science and natural science; implying that Design Science Research (DSR) could be considered as an alternative paradigm. Simon stated that design science research related "to courses of action that aimed to change existing situations into preferred ones". Unlike natural science, which aims to create knowledge as the primary output of the methodology (i.e., explaining 'how things are'), design science aims to output an artefact (i.e., a output that is concerned of shaping the world to how 'things ought to be'). Knowledge is created in design science within the artefact itself, making the artefact the key contribution of the research, however additional knowledge is gained by contextually applying the process of design science in practice. In the area of information systems, which traditionally results in the development of formal computer systems, design science is increasingly used as an alternative paradigm to support the systematic development of useable artefacts that obtain a goal in a practical way.

DSR can initially seem confusing, since it has been applied in IS literature as both a paradigm and a method, i.e., to either i) guide to development of the final research contribution, or ii) to act as a methodology - a set of systematic steps. To support to development of an artefact. To appreciate the distinction, it's useful to consider the Epistemological assumptions. When used as a paradigm, DSR focuses on problem-solving, which unlike natural sciences, is not focused on the development of knowledge as the primary outcome of research. This is counter intuitive to many, who define research as the creation of new knowledge, instead of the systematic investigation of a problem.

To make a distinction, i.e., between DSR and system development, Hevner et al. (2004, p.83) identified seven guidelines related to the development and use of design science: 1) the DSR solution should be designed as an artefact. Design science must produce an artefact in the form of construct a model, a method, or an instantiation; 2) The artefact must be developed to produce a technology based solution to satisfy an important and/or relevant business problem; 3) the utility, quality, and efficacy of the artefact must be "rigorously demonstrated via well-executed evaluation methods"; 4) The outcome must provide a clear and verifiable contribution in the area of design artefact, design foundations and / or design methodologies; 5) The research must apply rigorous methods in both the construction and evaluation of the design artefact; 6) the DRS research process is a cyclical problem-solving process, where solutions are tested against each other and against their efficacy for solving the problem. Moreover, the search for an effective artefact requires utilising of available means to reach desired ends or satisfying laws in the program environment; finally, 7) the solution must be presented effectively both to technology and management orientated audiences.

Interesting the focus of design science has been interpreted differently by different information systems researchers, and DRS has been applied as both a research paradigm and a methodology. This was first considered in the field of Information Systems research by Nunamaker et al (1990), who proposed a multimethodological approach to IS research (see figure 3.2). Nunamaker et al proposed that there are four research strategies to undertake information system research, i.e., Theory building, experimentation, observation, and systems development. Theory building includes development of new ideas, concepts, frameworks, etc. Theory building normally relates to understanding generic system behaviour, which is subjected to rigorous analysis. Sadly, however, because of the focus on theory then research contribution often provides limited practical relevance to the target domain. Experimental includes laboratory and field experiments, as well as computer and experimental simulation. Experimental designs bridge the gap between theory and practice, i.e., by guiding the future development (creation or iteration) of systems. Observation includes natural science research methodologies such as case studies, field studies, and surveys. Application of such methods can be used to formulate and test both specific and holistic hypothesis, however holistic conclusions are often limited by the provision of an exhaustive sample. Nunamaker et al. adapted the work of Curtis (1987) and proposed system development as consisting of five steps, i.e., concepts design, constructing the architecture of the system, prototyping, product development, and technology transfer. Nunamaker et al. defined system development as the hub of IS research, as other theories, observations, and experiments were contextually influenced by the existence, and form, of the system being tested. Moreover, contextual knowledge, concerning how the system is implemented, accepted, and used, is the basis of other research approaches.

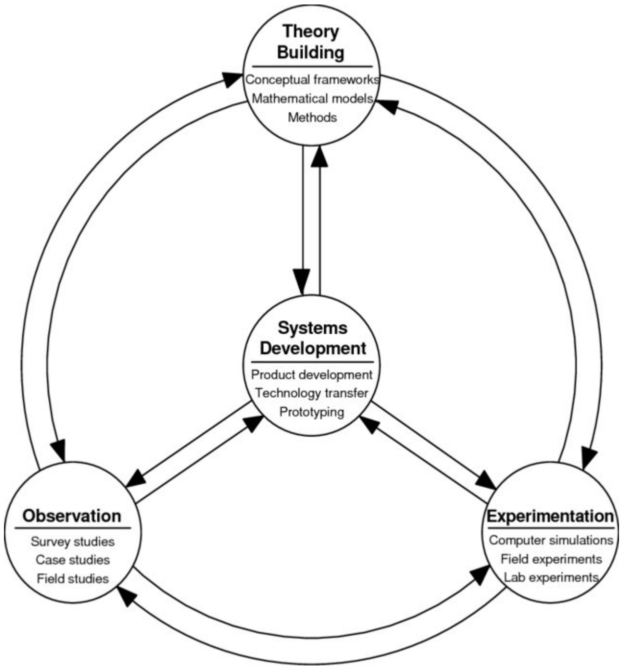


Figure 3.2. A multi-methodological approach to IS research (adapted from Nunamaker et al. 1991).

Within design science the focus is shifted from measurement (via experimentation or observation) of consideration of dysfunctional artefacts (software / technical / organisational systems, existing frameworks or concepts, or lists of factors, etc), to a focus on the development of an artefact that more practically meet the needs of stakeholders and results in satisfaction.

Conclusion

The research has two parts which have distinctly different research outcomes. RQ 1, discussed in part two of this thesis, aims to answer an explicitly question, i.e. Do MM258 students understand the systems models currently being taught to them? Accordingly, I need to either i) apply a positivist approach to measure empirically whether (or not) the student understands the key models being taught in the MM258 module, or ii) use a interpretivist paradigm to analyse student feedback concerning key IS concepts. Since we have explicit models, and are able to collect empirical data, I have decided to use quantitative analysis to answer this question. RQ2, discussed in part three of this thesis, aims to determine whether a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students. The outcome of this part is the development of a model artefact, and as such requires use of a design science approach. Accordingly, I will apply a pragmatic philosophy within this thesis.

3.3.2. Research Approaches

After considering the research paradigm (i.e., pragmatism), it is critical to consider the research approach (Saunders et al., 2012). Three approaches were described by Saunders et al., i.e., Deduction, Induction, and Abduction. Deduction - the prefix de- meaning 'from' – is the approach of deducing new knowledge from existing facts and premises. For example, your journey to work takes 30 minutes, and your new employer suggested that you should be at your desk at 9am. One day, however, you leave at 8.45am. You can deduce that on this day you will most likely be late, and that it is possible that you will get into trouble. Deduction is therefore dependent on accruing relevant facts, and critically assessing the outcome against the defined set of premises to determine the most desirable outcome – i.e., ensure you leave by 8.30am. Induction reasoning - the prefix in- meaning 'to' - is created based on observation alone. For example, if after a few weeks at your new job you realise that your new employer applies a McGregor Theory Y management strategy, i.e., employees are left to manage their own working hours, and no enforcement on a 9.00am start is applied, then you will be less concerned about rushing out the house for 8.30am. The third method, called abduction - the prefix ab- meaning 'away'- requires conclusions to be created based on known information. For example, if you notice a half-eaten piece of toast on the kitchen counter, you might abduct that your son, who you saw at 8am, realised he was going to be late for school (in a rush) forgot the toast half-eaten on the counter, and left. We do not know it to be true, but it is the best approach that fits the known facts. If a researcher requires all the facts and premises before a conclusion can be made, then a researcher is using deduction. If the conclusion is made on observation (possibly without appreciation for reasoning) then a researcher is using induction. If outcomes are defined from logical rationality, based on what we know to exist, then a researcher is applying abduction.

To answer Q1 I need to collect data in advance and analyse this data in order to determine whether the students understand the IS models being presented in MM258. As such all the information is required before effective checks and exploratory factor analysis can be undertaken. As such, to consider Q1 in part two of this thesis, deductive research approach will be used to determine empirical facts, however abduction will be used in the creation of conclusions where facts are in question. To answer Q2 I aim to iterative design a solution, based on logical and systematic reasoning, to support the teaching of complex system thinking to pre-experience UG students. As such an abductive research approach will be used in part three of this thesis.

3.3.3. Research Methodologies

After considering the approach, I critically considered the research methodology (Saunders et al., 2012). If a single form of data is collected and analysed, i.e., conducting either qualitative or quantitative research, then the research is applying a mono-method. If quantitively research methods are applied, and then qualitative research methods, then you can elaborate areas that are identified as being quantitatively significant. If qualitative research methods are applied before quantitative research methods, then the problem domain can be elaborated, i.e., allowing a researcher to identify new impactful constructs, but the significance of new factors can then be tested. Use of multiple sequential methods – e.g. Qual / Quant / Qual or Quant / Qual / Quant (i.e., a mixed methodological approach) – allows a researcher to recursively elaborate theoretical constructs involved in a problem, identify the significance of those constructs, and then iteratively drill down (as far as it required) to low-order factors, to qualitative understand what factors are critical, and quantitively how factors interact. Methods may be applied in parallel within the same study (a complex mixed method) to allow the research to determine whether theory from certain frames of reference more closely aligns to the data captured from within the domain.

To answer Q1 the research will apply a qualitative research methodology to support capture of empirical data. To answer Q2 I will apply design science as a methodology, i.e., as a structure to support iterative development of step-by-step artefacts that progressively incorporate and address several issues and problems.

3.3.4. Research Strategies

After considering the methodology, I critically considered the research strategy and the time horizon implications for both research question, i.e., the method by which relevant data will be collected, and the time required to effectively implement this method (Saunders et al., 2012).

Although the list is not exhaustive, Saunders et al. (2012) suggested a range of possible methods: Experiment, Survey, Archival research, Ethnography, Case study, Action research, Grounded theory, etc.

Experimental methodologies require a researcher to i) control and manipulate independent variables, and ii) measure the resultant impact of defined / measurable dependent variables. If a dependent variable is significantly (and consistently) impacted by changes in the independent variable, then a cause and effect can be identified. Experimental methodologies require a strategically designed and controlled set of tests to minimise the impact of confounding variables - such as individual differences or experimental order effects.

Survey methodology studies the sampling of individuals, as a means of collecting information about the views of a specific population. As such the survey data collected it's dependent on a researcher's ability to effectively formulate question items and target a population that is representative of the problem domain. Surveys can be open, semi-structured, or structured in nature; with the structure of the question impacting the ability of research to elaborate domain features. Structured questions, particularly with Likert scale feedback support a researcher in undertaking remote collection of known data items, e.g., via structured questionnaires, and facilitates the analysis and modelling of specifically pre-defined factors. Open questions can facilitate elaboration of a researcher's understanding of domain factors, but use of open questioning i) more commonly requires application of face-to-face interviews instead of automated and/or remote collection of data, and ii) enquires data to be analysed qualitatively by extracting contextually coded themes.

Archival research requires the study of historical and/or research documents to understand what happened in the past. By looking at institutional records from the past, and over time, and by comparing and modelling a range of factors, archival researchers can identify cause / event relationships that exist in factors that still exist today. Archival research outcomes are dependent on the future being the same as the past, however learning from mistakes made in the past can certainly help decision makers. Ethnography methods requires a researcher observing people, within a particular location or within a contextual cultural setting, with the aim of better understanding the interaction of that individual within that specific cultural environment. Ethnography can provide rich data about human behaviour, however, often requires on an objective researcher to undertake participant observation across prolonged durations of time (longitudinal study). Some researchers claim that ethnography is a methodology, since a range of methods (both quals and quants) can be applied within Ethnography; those observations are mostly qualitative. Analysis of ethnography data is critically bounded to the interpretation of a researcher, and therefore is prone to observation bias (LeCompte, 1987).

Case study methodology is normally applied as a qualitative strategy (Baskarada, 2014) that requires a researcher to critically consider several ‘cases’, which act as instances of a specific issue or problem (see Pankratz and Basten, 2013). By considering a range of examples where are specific phenomenon occurs, a researcher can inductively observe or abductively conclude where the problem occurs. There are a number of different types of case study methodology, e.g. collective case studies which requires a researcher to involve a large group of individuals; descriptive case studies which requires the research to start with the descriptive theory against which observed information is compared; explanatory case studies which require a researcher to consider the causal impact of factors; exploratory studies where a researcher uses consideration of cases as the starting point for more in-depth research; instrumental case studies where the population trust the specific researcher enough to allow him/her with information that is not normally observed; and intrinsic case studies which occurs when a researcher is emotionally / personally connected to the case.

Action research methodology is most used in the domain of social sciences as a strategy to interactively make changes by iteratively progressing through a) input/planning (unfreezing), b) transformation/action (changing), and c) output/results (refreezing) stages (Lewin, 1958). Feedback loops exist between i) changing to unfreezing, ii) refreezing to changing, and iii) refreezing and unfreezing stages, to allow changes in respectively i) planning if an action is incorrect, ii) action if results is incorrect, and iii) planning if results are incorrect. Once the change is refrozen the new behaviour is tested, and (if more impactful) in included is the system’s repertoire of problem solving.

Grounded theory methodology is an inductive qualitative method strategy that is used when no existing theory exist to explain the phenomenon being studied. By conducting interviews with real-world participants, the research develops concepts that accurately represent the problem domain. A researcher captures and analyses data in parallel, allowing a researcher to collect enough data, in specific areas, to explain analysis findings. Saturation only exists when no new constructs or factors are identified.

Design Science Research (DSR) can be used as a research methodology strategy, e.g., Vaishnavi and Kuechler, 2004, to support the iterative development of solution artefacts. Vaishnavi and Kuechler (2004) used DSR as a method, iterative applying i) awareness of the problem, ii) suggestion, iii) development, iv) evaluation, and v) conclusion steps to support the effective creation and evolution of specific design artefacts.

To address RQ1 I will use a survey methodology, with a separate survey developed for each model, which will be use interactively to collect data from MM258 students as part of taught seminar session — i.e., at the point when IS models are presented to students; and across a numerous cohort samples. It is important to collect data in the teaching space as this ensure that the data collected reflects student initial understand concerning what was just taught. To address RQ2 I will use a relevant design science methodology. Two main types of DSR framework have been developed to support application of DSR, i.e., the ''build-evaluate'' cycle (e.g., Hevner et al, 2004, March and Smith, 1995), often linked to consideration of DSR as a paradigm, and the process feedback loops (Vaishnavi and Kuechler, 2004, Peffers et al., 2007), linked to creation of iterative artefacts and use as a methodology. Since several DSR methodologies are used in literature the following section will consider this issue in more detail.

3.4. Expounding Design Science Research

To understand the variation of Design Science Research (DSR) use, Pascal and Renaud (2020) made a comprehensive literature review of DSR literature. Pascal and Renaud collected research citations from a basket of eight top information systems journals (i.e., EJIS, ISJ, ISR, JIT, JSIS, JASI, MISQ, JMIS) using a range of search terms. In total 192 articles were identified that had either used or applied design science research. Pascal and Renaud use four common approaches to analyse results: i) citation and co-author analysis frequency, ii) co-citation analysis (CCA), iii) bibliographic coupling (BCA) i.e., to understand the usage and contribution scope of each paper, and iv) semantic analysis to understand the meaning of the study. Using clustering Pascal and Renaud were able to group articles into five colleges (see figure 3.3 and table 3.1).

Table 3.1. IS DRS core references (adapted from Pascal and Renaud, 2020).

Cluster	Reference	Year	#cit	%	Type
1	Benbasat & Zmud	1999	10	5%	GENIS
1	Benbasat et al.	1987	10	5%	METH
1	Eisenhardt	1989	13	7%	METH
1	Gregor	2006	40	21%	ISDSR
1	Iivari	2007	25	13%	ISDSR
1	Klein & Myers	1999	14	7%	METH
1	Lee & Baskerville	2003	12	6%	METH
1	Miles & Huberman	1994	12	6%	METH
1	Orlikowski & Barodi	1991	10	5%	GENIS
1	Orlikowski & Scott	2008	10	5%	GENIS
1	Schön	1983	12	6%	METH
1	Yin	2013	27	14%	METH
2	Benbasat & Zmud	2003	16	8%	GENIS
2	Checkland	1981	10	5%	GENIS
2	Davis	1989	13	7%	GENIS
2	Kuhn	1970	10	5%	METH
2	Leonardi	2011	11	6%	GENIS
2	Rogers	1995	13	7%	GENIS
2	Simon	1969	64	33%	ISDSR
2	Venkatesh et al	2003	14	7%	GENIS
2	Weick	1989	11	6%	GENIS
3	March & Smith	1995	63	33%	ISDSR
3	Markus et al.	2002	46	24%	ISDSR
3	Orlikowski & lacono	2001	35	18%	GENIS
3	Vaishnavi & Kuechler	2004	11	6%	ISDSR
3	Van Aken	2004	16	8%	ORGDSR
3	Walls et al.	1992	72	38%	ISDSR
3	Walls et al.	2004	14	7%	ISDSR
4	Baskerville & Myers	2004	11	6%	METH
4	Cole et al.	2005	10	5%	ISDSR
4	Davison et al.	2004	11	6%	METH
4	Goldkuhl	2012	10	5%	ISDSR
4	Sein et al.	2011	38	20%	ISDSR
4	Susman & Evered	1978	11	6%	METH
5	Abbasi & Chen	2008	10	5%	ISDSR
5	Baskerville & PriesHeje	2010	14	7%	ISDSR
5	Gregor & Hevner	2013	43	22%	ISDSR
5	Gregor & Jones	2007	59	31%	ISDSR
5	Hevner	2007	20	10%	ISDSR
5	Hevner & Chatterjee	2010	10	5%	ISDSR
5	Hevner et al.	2004	140	73%	ISDSR
5	Kuechler & Vaishnavi	2012	10	5%	ISDSR
5	Nunamaker et al.	1991	37	19%	ISDSR

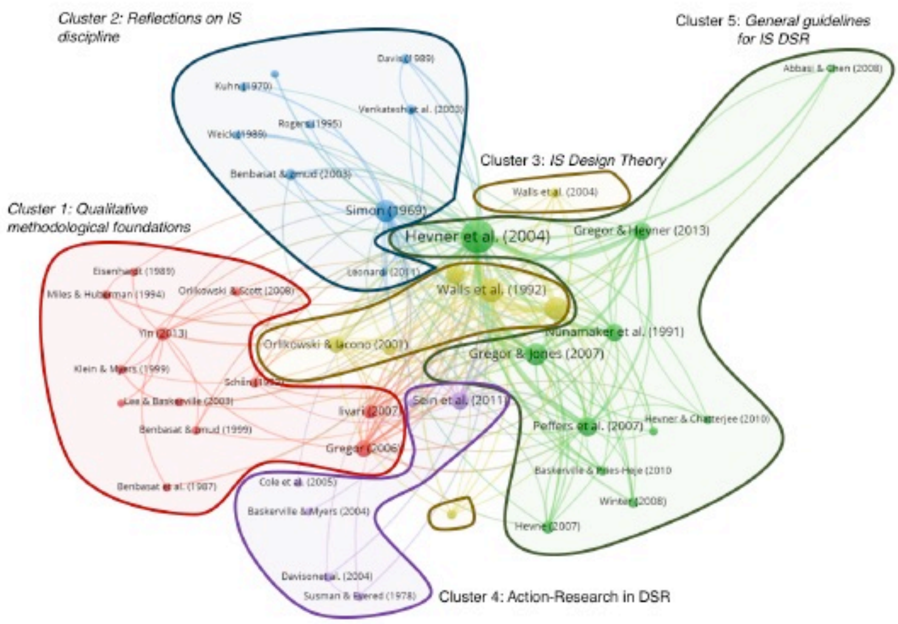


Figure 3.3. Information Systems DRS literature cluster
(adapted from Pascal and Renaud, 2020).

Cluster one relates to ‘Qualitative Methodological Foundations’. This cluster composes of studies that question and discuss the state of IS theory, and the contribution of various qualitative methodologies being applied. Cluster 2 relates to ‘Reflections on the IS discipline’, and is composed of research that aims to investigate the complex situations encountered by IS researchers. Cluster 3 relates to ‘Information System Design theory, which suggest that DRS research is primarily responsible for the development of IS design theory. Cluster 4 relates to use of action research in information system design science, and epistemological questions about how to practically integrate IS design theory into real-world solutions. Cluster 5 Relates to formation of ‘General Guidelines for Information Systems Design Science Research’. This area creates rigorous prescriptive guidelines to structure how information systems should be applied. See Table 3.1 for a list of the most cited DSR articles presented by Pascal and Renard. In our research we aim to address two research questions: a) in part 2 of this thesis, to understand what pre-experience management students understand when taught current systems model, and b) in part three of this thesis, to develop a holistic model, which is i) simple enough to be used with UG teaching, ii) structured enough to incorporate a range of key IS literature, and iii) extensible to allow future development.

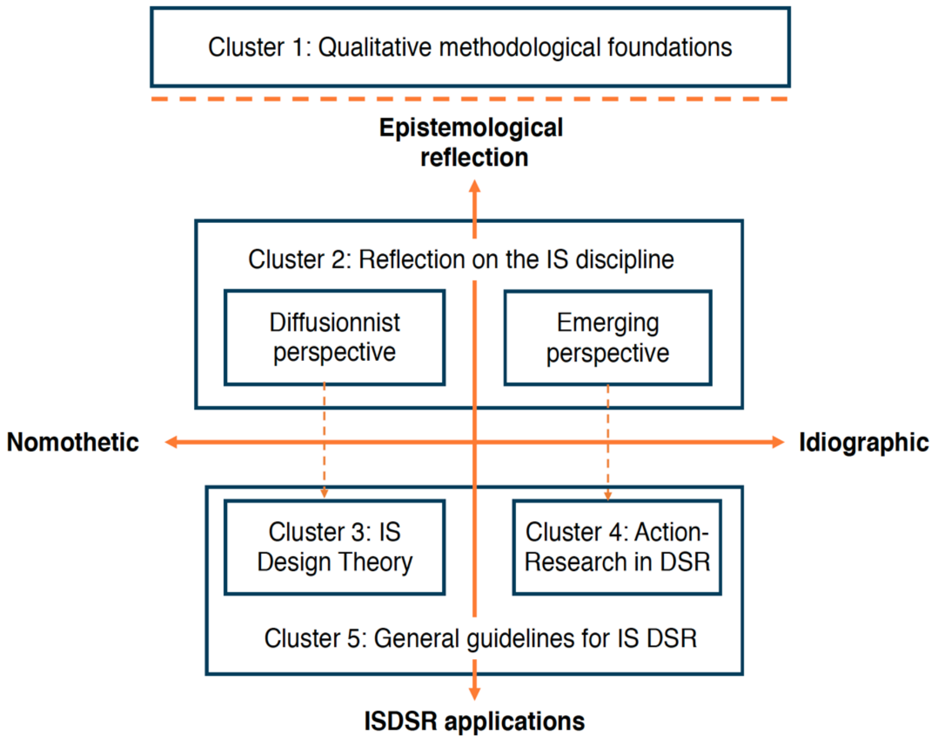


Figure 3.4. DRS colleges – a integrated framework proposed by Pascal and Renard (2020)

The outcome of this thesis demands an artefact that is practically applicable within a specific context, i.e., the teaching of a range of complex Information Systems theories. Accordingly, the purpose of clusters 1, 2 and 5 DSR studies (see figure 3.3), which respectively consider i) the role of qualitative methodologies, ii) focus on a specific domain and/or list of bounded factors, or iii) developing a perspective set of guidelines, appears contextually unhelpful to formation of a holistically focused artefact.

The key difference between cluster 3 and 4 relates to whether our research is nomothetic (relating to the study or discovery of general scientific laws) or idiographic (a study of particular scientific facts and processes). Cluster 3 relates specifically to understanding information system design theory. Within table 3.1 cluster 3 is represented by seven core articles, with CCA analysis implying that cluster 3 methodologies could be used in the development of IS design theory.

Vaishnavi and Kuechler (2004) adapted Nunaker's (2004) core research cycles to develop more explicit process steps and feedback loops (see figure 3.5). Vaishnavi and Kuechler (2004) define DSR as a "lens" or set of synthetic and analytical techniques distinguished from routine design by the production of outstanding (to a community) new and true knowledge, i.e., to produce a new artefact using state-of- practice application with state-of-practice techniques and readily available components to a desirable level. Instead of producing a single outcome artefact, as suggested in Hevner (2007), Vaishnavi and Kuechler (2004) propose development of regular artefact outcomes; each iteratively considering a different problem aspect. Vaishnavi and Kuechler (2004) defined five sequential steps, with iteration of the five steps occurring as a result of circumscription, which is a restriction or limitation within the current artefact. The 'Design Science process research Model' (see figure 3.5) starts with the awareness of the problem stage, wxhich requires the issue / problem being addressed in the current definition. Within the first iteration the 'awareness of the problem' stage focuses on consideration of the literature to elaborate details of the problem. The second 'suggestion' stage applies existing knowledge and theory to identify a solution to the issue / problem defined in stage one, i.e., by adapting the previous output artefact. The suggestion stage is where creative solutions and new knowledge is formed (Vaishanavi and Kuechler, 2004). A critical evaluation of options is also optionally included, as key points, to check whether a satisfactory outcome has been achieved. Within the first iteration existing solutions in literature are critically considered to select the best kernel solution, i.e. the artefact taken from literature that most closely addresses the defined problem scope.

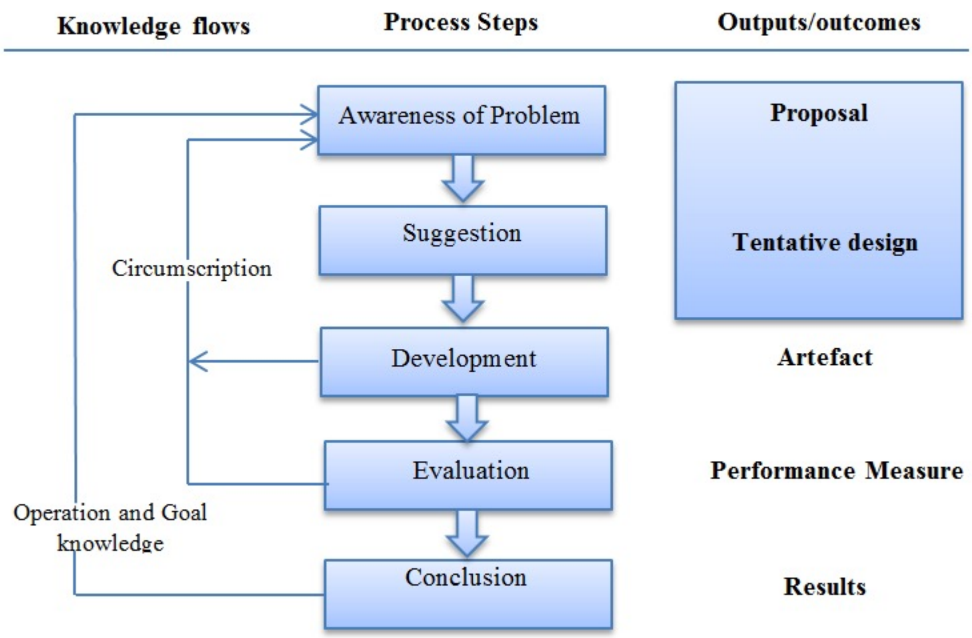


Figure 3.5. Design Science process research Model, adapted from Vaishnavi and Kuechler (2004).

3.5. Conclusion

In this chapter I used Saunder's onion to systematically introduce and consider adoption of: research philosophies, research approaches, research methodologies, and research strategies.

Two research questions are being addressed in this research, which require distinctly different research approaches, methodologies, and strategies. Accordingly, a pragmatic research paradigm will be adopted as an umbrella in this research. To answer RQ1, in part two of this thesis, a deductive research approach will be used to determine empirical facts, however abduction will be used in the creation of conclusions where facts are in question. To answer Q2 I aim to abductively research approach will be used develop a holistic system model, based on logical and systematic reasoning, to support the teaching of complex system thinking to pre-experience UG students. To answer Q1 I will apply a qualitative research methodology to support capture of empirical data. To answer Q2 I will apply design science as a methodology, i.e., as a structure to support iterative development of step-by-step artefacts that progressively incorporate and address several issues and problems. To address RQ1 I will use a survey methodology, with a separate survey developed for each model, which will be use interactively to collect data from MM258 students as part of taught seminar session – i.e., at the point when IS models are presented to students. It is important to collect data in the teaching space as this ensure that the data collected reflects student initial understanding concerning what was just taught. To address RQ2 I will use the Vaishnavi and Kuechler (2004) design science methodology strategy, which consists of five iterative steps – i.e., awareness of the problem, ii) suggestion, iii) development, iv) evaluation, and v) conclusion steps to support the effective creation and evolution of specific design artefacts. Evaluation will be done optionally to test artefact satisfaction, and a conclusion is done at the end of the DSR process.

PART TWO

UNDERSTANDING STUDENT PERCEPTION
and
DEFINITION OF THE KERNAL THEORY

Chapter 4
Understanding Pre-experience Perception of Systems Models : Defining Artefact 1

4.1. Introduction

This chapter has three key outcomes. Firstly, I will introduce the reader to the three information systems models currently taught in the M258 module, in order to highlight the distinct differences between models, and the diverse range of information being presented across the models. Secondly I will capture empirical quantitative data from MM258 seminar sessions to consider the first research objective, i.e., to understand what pre-experience students assimilate/learn when presented a range of information systems models of increasingly abstraction and complexity. The result from analysis aims to highlight whether pre-experienced students appreciate the core points being discussed in seminar sessions. Finally, because of critical analysis, I evaluate which of three models currently being taught would best act as the base design science artefact, i.e., the kernel theory, upon which subsequent evolution will be made to support development of a holistic systems teaching model.

4.2. Current MM258 Information Systems models

In this section I will introduce the reader in detail to three systems models being considered, i.e., the Dual Aspect system conflict Model (Nadee et al., 2017), the UTAUT2 technology acceptance Model (Venkatesh et al., 2012), and Pankratz and Basten failure model (Pankratz and Basten, 2013). The three models were selected for consideration in this research because i) they are all currently discussed in the MM258 module, entitled ‘An Introduction to the management of Information Systems’; and are used to i) introduce pre-experienced students to a distinct information systems issue, i.e., respectively systems conflict, technology acceptance, and information systems failure; and ii) because they demonstrate a progression in their level of complexity.

4.2.1. Dual Aspect Model – Systems Conflict

Whilst mapping human systems in culture, Edward Hall (1959) proposed the concept of the "crucial trio". The "Crutual Trio" states that human systems are constructed of three distinct norm layers, i.e. formal norms (beliefs/concepts), informal norms (behaviour, action) and technical norms (logics, tools, rules, processes) – see figure 4.1.

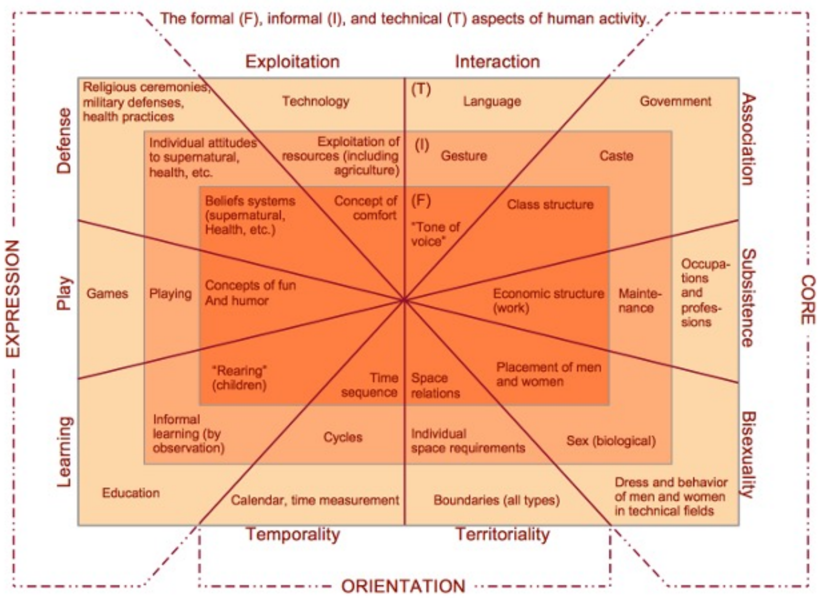


Figure 4.1. Hall's Major Triad adapted from Hall (1959).

In Hall's human-focus definition of systems, 'formal norms' lay at the core of the self, and convey the concepts, reasons, and purposes why the system does what it does. For example, within Hall's 'Learning' message system (see bottom left of figure 4.1), 'formal norms' define why education is required, i.e., to effectively 'rear' – bringing up and caring for – children. Informal norms, defined within the middle layer, support formal layer norms through behaviour and activity. For example, within the 'Learning' message system, at the informal layer, students learn via experimental observation, and by understanding 'good practise'. Within the technical layer, i.e., the outer concentric circle, technical norms are applied to physically express the concept in practice (Hall, 1959). Technical (in Hall) relates to any physical expression of the informal norm and was not intended to be limited to just computer-based solutions. For example, within the 'Learning' message system, at the technical layer, technical tools, curricula, rules, vocabulary, etc., are applied to facilitate students (with key skills and abilities) in the experimental observations at the informal level. Within Hall's model, activity in the outer technical layers is driven by the need to develop mechanisms to practically express the norms held within inner layers. Outer layers are therefore dependent on the inner layers, and a flow of expression moves from the core, i.e., the 'formal' (belief) layer, through the 'informal' (behaviour) layer, and is expressed in the outside world in the 'technical' (tool) layer. Although external influences can influence inner layers, this must be done by interacting with, and influencing, norms against the flow of dependence; making it difficult to influence the system core.

Hall's concentric 'crucial trio' layers, and consideration in context of the ten message systems (see figure 4.1), allowed Edward Hall to map specific aspects of human culture (e.g., play, learning, interaction, etc.). The ability to map an individual's cultural norms facilitated comparison between individuals. This comparison allowed Hall to understand the interplay and conflict between individuals and people groups. Cultural norms may be impacted by the environment, but norms are learnt over time from those that surround you, often in infancy; providing the beliefs, knowledge, and skills that an individual needs to thrive in a specific culture or social context.

With a focus on the development of technical business systems, Stamper (1973) embraced, yet adapted, Hall's crucial trio concept. Ronald stamper, known for his work in the field of Semiotics, Stamper proposed a way of looking at organisation's activity through a semiotic lens. Semiotics is the study of signs, i.e., the consideration of the information interpreted from an object; due to the interaction between three elements (object / sign / interpretant) - in the 'semiosis process' (see figure 4.2).

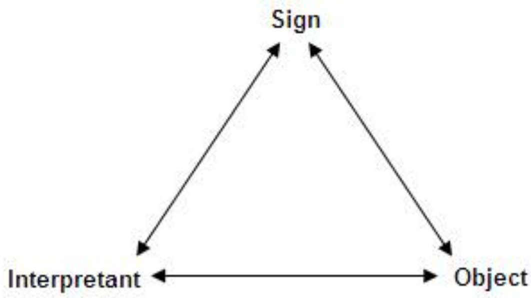


Figure 4.2. Peirce's Triad of Semiosis (adapted from Stamper, 1973).

Moreover in 1993, Stamper proposed the semiotic ladder (see table 4.1), which exists of two worlds: the IT world (relating to physical, empiric and syntactic layers of activity), and the social world (relating to semantics, pragmatics and social layers of activity). Stampers physical layer relates to the physical properties of the physical object, i.e., hardware and signals. The empiric layer focuses on patterns of the physical, such as data encoding. The syntactic layer is concerned with the structures, such as languages and databases expressed by the empiric layer. The semantic layer focuses on the meanings of sign. The pragmatic layer is concerned mainly with intention. The social layer represents social systems, which consists of beliefs, culture, law, commitments, etc. Interestingly, Stamper, who was focusing on development of technology, linked pragmatic and social layers together to create a Informal layer – representing the reason for the system, i.e., 'the system intent'. Syntactic and semantic layers were linked together to create a formal layer – representing how intent is transformed via 'system plans'. Physical and empiric layers were linked together to create the technical layer – representing the mechanism that describes 'how' the system works.

Table 4.1. Semiotic Framework aligned with the Semiotic Onion.

<table>
<tr><td rowspan="3">Social World</td><td>Social</td><td rowspan="2">Informal</td><td rowspan="2">Meanings
Intentions
Beliefs
Commitments</td></tr>
<tr><td>Pragmatic</td></tr>
<tr><td>Semantic</td><td rowspan="2">Formal</td><td rowspan="2">Forms
Rules</td></tr>
<tr><td rowspan="3">IT World</td><td>Syntactic</td></tr>
<tr><td>Empiric</td><td rowspan="2">Technical</td><td rowspan="2">Mechanism</td></tr>
<tr><td>Physical</td></tr>
</table>

To support a flow from informal to technical, which is different to Hall, Stamper created the 'organisational onion' (see figure 4.3), to support academics and practitioners in the effective capture from organisations of software requirements. Stamper claimed that trends in society shape the informal organisational norms (i.e., intentions and beliefs), which is on the outer layer of stamper's onion. Changes in informal norms will themselves shape the rules and processes used within the systems, i.e., the middle onion layer. System rules and processes changes then drive development of a technical or automated systems to facilitate efficiency. Accordingly, the outcome of the organisational onion is the definition of technical solutions that most effectively facilitates the operation of formal system (form, processes, and rules), which itself support the informal purposes of the organisation (intention, beliefs, etc.) – thus impacting society.

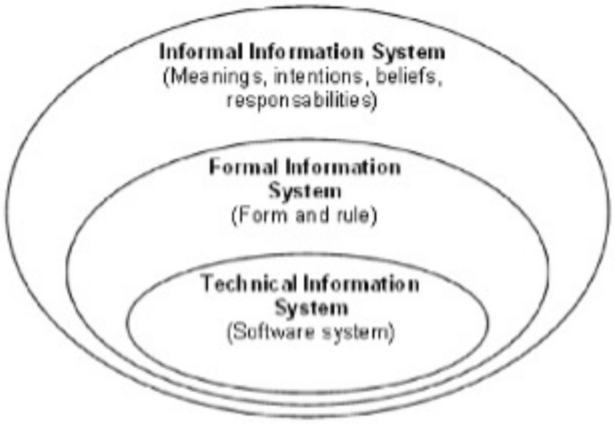


Figure 4.3. Organisational Onion (adapted from Stamper, 1993).

The organisational onion has been widely adopted within the semiotic research community with the aim of using norm definitions to identifying technical system requirements, and guide technology development. For example, Wiafe et al. (2011) adapted the semiotic onion to consider what factors influenced selection of persuasive technologies. Jacobs and Nakata (2012), applied the organisational onion to analyse social media usage within an organisation. Chai-Arayalert and Nakata (2013) adopted the organisational onion in the knowledge management domain, where they used the three layers to classify the context of knowledge transfer between two organisations, i.e. the source and the recipient. Li et al. (2014) also used the organisational onion to classify individual practical treatments, in order to propose integrated health clinical pathways.

Nadee, Gulliver, and Ali (2017) compared Hall and Stamper norm layers and highlighted some significant inconsistencies in the use of layout order and norm definitions. In Hall's model a person's concepts and beliefs (termed 'formal') results in the creation of behavioural intention (termed informal). This behavioural intention is only realised in the real world, however, if the behavioural intention is processed through the technical layer (table 4.2). Halls claims that the external layer of all systems (technical, human, organisational) is the technical layer, and that interaction between systems can only be achieved if technical alignment is achieved (e.g., use of a consistent language). In Hall's model (see figure 4.1) information flow is meant to be bi-directional, i.e., from society to formal level (through the technical, informal) and from formal to society (through informal and technical) - however Hall suggested that flow formalised over time due to social conditioning. The purpose of Stamper's semiotic onion was to aid in the development of IT systems to support business activity. Accordingly, the central layer in

Stamper's model is the technical layer. The technology requirement is defined by the rules and processes within the formal layer (the central semiotic onion layer), which is influenced by the informal layer (the external onion layer). Stamper's onion was never intended to represent human systems and/or the modelling of interaction between systems. Information flow in Stampers Onion flow from external source (in society) to the technical (through the informal and formal layer), i.e., no flow from technical to informal is implied.

Table 4.2 - Comparison of Crucial Trio and Organisational Onion (adapted from Nadee et al., 2017).

	Hall's crucial trio	Stamper's onion
Layer 1 (core)	formal – concept and beliefs	Technical – technology, software systems
Layer 2	Informal – behaviour, action	Formal – written rules, processes
Layer 3 (outer)	Technical – logics, tools, rules, processes	Informal – meanings, intentions, beliefs

There was considerable cross over in the definition of 'Informal' in the Hall and Stamper models, however the Formal layer in Hall's model, which relates to the individual's background beliefs (see table 4.2), does not have an equivalent layer within Stamper's semiotic onion (see table 4.3, which shows the alignment of crucial trio layers Halls and Stamper models).

Table 4.3 – Original semantic mapping of Crucial Trio and Organisational Onion layers – order of Stamper layers reversed - see table 4.2 (adapted from Nadee et al., 2017).

Hall's crucial trio	Stamper's onion
Formal (F)	
Informal (I)	Informal (I)
Technical (T)	Formal – written rules, processes (F)
Technical (T)	Technical – technology (T)

Nadee, Gulliver, and Ali (2017) proposed that all systems (technical, organisational, and/or humans) should place the 'Why' at the core of the system. This structure mirrors the golden circle (see figure 4.4), as defined by Simon Sinek, is similar in critical structure to Cury's (1983) 'onion model of learning styles, the and aligns with both anthropological, organisational, and biological research concerning decision making. Although Stamper's semiotic onion has strong definitions for technical, formal, and informal norms, the order of layers is bound by a fixed raison d'être (i.e., reason for being), which relates to the creation of IT solutions. Stamper's onion was developed for a specific purpose, which is fine, however failure to explicitly consider conceptual norms means i) that Stamper's onion is of limited value during wider consideration of system dynamics, and ii) Stamper's onion is limited to consideration of technical solution development; limiting consideration with business and management focused systems.

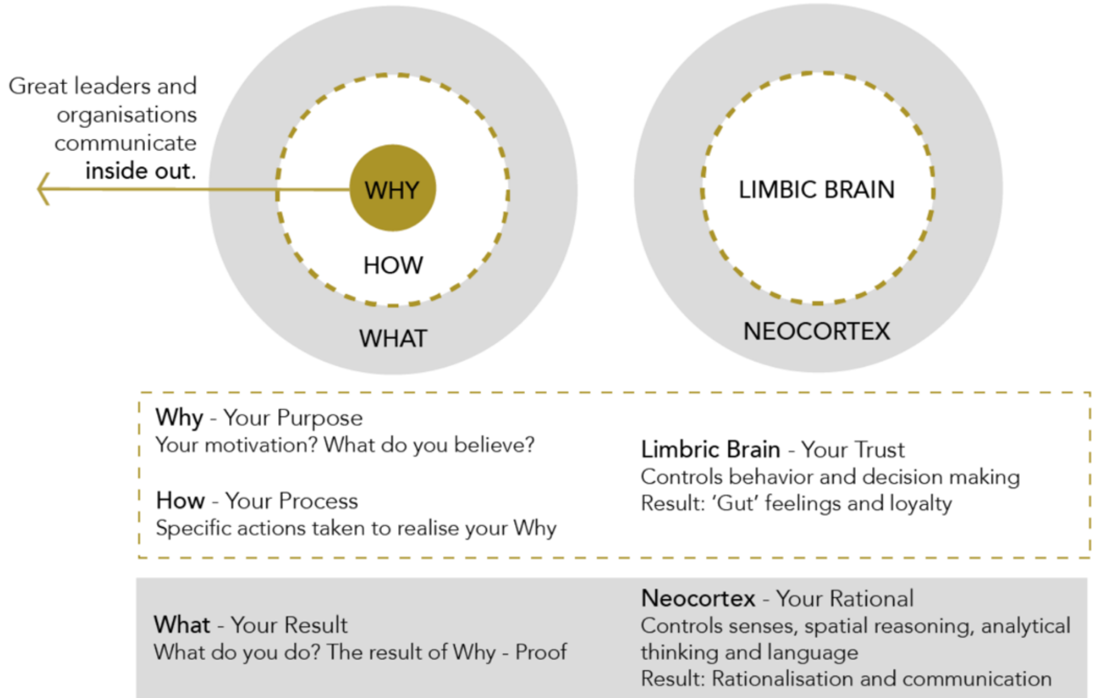


Figure 4.4 – The Golden Circle (adadpted from Sinek, 2009).

To fill the Stamper's definition gap, i.e., no consideration the 'Why', Nadee et al. added a fourth conceptual layer to their onion model (see table 4.4) – a model which they termed the 'Dual-aspect model'. The addition of a fourth layer to the dual-aspect model (see figure 4.5) provides a clear distinction between formal and informal norms, as defined in stamper's onion, yet still allows the focused consideration of concepts and beliefs.

Table 4.4: Adapted Mapping of Crucial Trio and Dual- Aspect (adapted from Nadee et al., 2017).

Hall's crucial trio	Dual
Formal **(F)**	**Concept (C)**
Informal **(I)**	Informal **(I)**
Technical **(T)**	Formal – written rules, processes **(F)**
Technical **(T)**	Technical – technology **(T)**

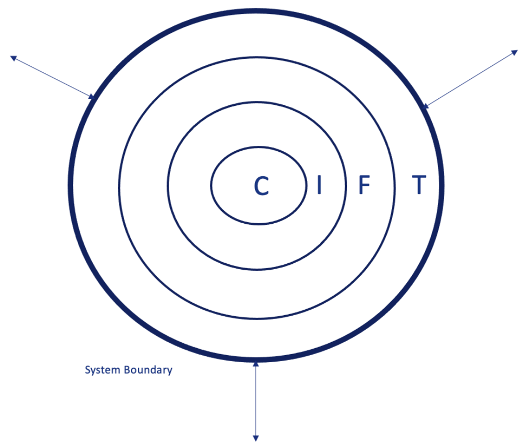


Figure 4.5 – Dual Aspect Model (adapted from Nadee et al., 2017).

Moreover, by using i) a layer structure similar to Edward Hall's 'Crucial Trio' (see figures 4.1 and 4.4), i.e., with the technical layer interacting with society, ii) by incorporating Stamper's norm definitions (removing the confusion of the term 'formal'), and' iii) by adding a conceptual layer to all systems (technical, organisational, and/or humans), Nadee et al. (2017) proposed a structure that not only can represent all types of systems (i.e., humans, organisations, and technology), but can consider the interaction of system norms (see figure 4.6). Nadee et al. (2017) proposed that when two systems interact (e.g., a human interacting with a technology, or a technology being used within an organisation, or a human working for an organisation, etc.) there is an interaction of norms. Nadee et al. (2017) described a situation where an old system (on the right of figure 4.6) interacts with a new system (on the left of figure 4.6). Systems technical, formal, informal norms therefore interact – with the level of interaction depending on the level of interaction between the two systems. For systems to work effectively (as in the case of IT implementation, or an organisational merger) alignment between technical, formal, informal, and possibly conceptual norms, are required (though Nadee et al. (2017) assumed that alignment of conceptual norms was not critical to support operational interaction).

As a result nine interaction points were identified between the technical, formal, and informal norms of the new system (on the left) and the old system (on the right). These interaction point were: TT, TF, TI, FT, FF, II, IT, IF, II (see figure 4.6); where, for example, TF represents technology in system A that is not currently supported by the current processes, rules, and structures used in system B, etc. If misalignment exists between the system norms, then alignment of norms could only occur if either i) the old system was changed to align with the new system, ii) the new system was changed to align with the old, or iii) both systems are removed and an alternative is introduced. These two conflicting aspects of change – old and new – led to the model being called the dual-aspect model.

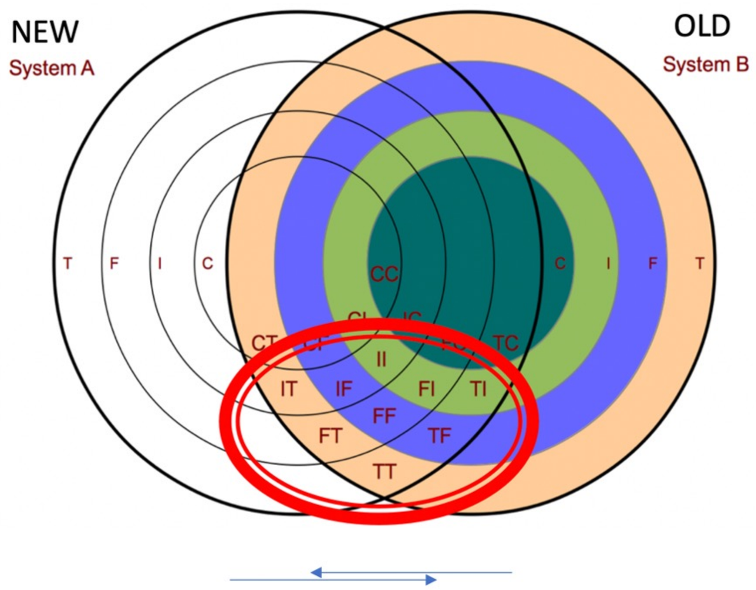


Figure 4.6. Dual-Aspect Model - Nine system interaction points.

To validate the proposed model, Nadee et al. (2017) collected empirical data using a questionnaire. Participants in industry were asked about the technologies that they used within their business. For each of the technologies used, Nadee et al. (2017) asked a series of questions relating to i) technology perception, ii) cognitive dissonance, and iii) the dual- aspect of change. Technology perception data was captured using the Kano et al. (2004) model to compare positive question and negative questions, on a 5 point like at scale, allowing respondents to quickly express their preference concerning a particular technology (i.e., were they positive or negative towards the technology). Noriaki Kano developed the KANO model to distinguish between four forms of features: i) must-be features, ii) one-dimensional features, iii) attractive features and iv) indifferent features (Kano et al., 1984). Must-be quality features, known as basic quality features, are those customers expects to be present. Must0be features are often unnoticed, however customers are very dissatisfied when must-be features are not present (Zhang and von Dran, 2001). One-dimensional features result in increases in customers' satisfaction when present, and dissatisfaction when not; suggesting that presence of these features is noted and appreciated. Attractive features are not normally expected as standard by consumers but delight when included. Existence of an attractive feature increase consumer satisfaction, however costs money. Absence of an attractive feature will not lead to dissatisfaction, as these are rarely expected. Finally, indifferent features refer to attributes that have no impact on customers' satisfaction – and may not be wanted by customers.

Nadee et al. (2017) used eight questions (using a 5-point Lycett scale) to gain feedback concerning each technology used:

"Q01 - The new technology can be fully used in the organisation".

"Q02 - The new technology is required to be customised as it doesn't fit well at the first place (CNT)".

"Q03 - The existing technology is required to be customised to be compatible with the adopting technology (CCT)"

"Q04 - The new process is required to change to fit with the current business system (CNP)"

"Q05 - The existing process is required to change to support the new adopting process (CCP)",

"Q06 - People will need to change their way they work once the technology is adopted in place (CCB)"

"Q07 - Interaction with the adopting technology is required to be customised to minimise impacts to people's behaviour (CNB)"

"Q08 - People won't use the new adopting technology at all".

The first (Q1) and last questions (Q8) collected data about user intention (positive or negative) towards the use of the technology. Questions 2 to 7 asked questions specifically about change to specific norm points, i.e., Q2 – New Technical, Q3 – Old Technical, Q4 – New Formal, Q5 – Old Formal, Q6 – New Informal, and Q7 – Old Informal. Scores for conflict points was collected by combing the Lycett scores for specific change points, e.g., TT is formed by combing feedback for CNT and CCT (questions 2 and 3) – see figure 4.7.

	System A		System B	
TI = CNT+CCB	TF = CNT+CCP	TT = CNT+CCT	FT = CNP+CCT	IT = CNB+CCT
	FI = CNP+CCB	FF = CNP+CCP	IF = CNB+CCP	
		II = CNB+CCB		

Figure 4.7 – Creation of conflict data points from Kano et al. model questions.

Nadee et al. (2017) collected numerous data points concerning technology use and misalignment, process use and misalignment, activity and behaviour use and misalignment, technology perception, attitude towards behaviour, current behaviour, and attitude towards change. A SEM structural model was developed and tested to investigate the flow and relationships between technical, formal, informal, and conceptual layers (see figure 4.8) in the domain of innovation (accessing the impact of core layers as a result of external change). Results show that technical 'Technology misalignment' affects formal 'Process misalignment' (0.697***), however it also significantly (and directly) impacts informal 'People behaviour misalignment' (0.245***). Formal 'Process misalignment' mainly influences informal 'People behaviour alignment' (0.441***), which in turn has a relationship with individual the personal's conceptual 'Dissonance state' (-0.704*). Lastly 'Cognitive dissonance' affects 'Technology perception' (-.084***), however these were both considered to exist within the concept layer.

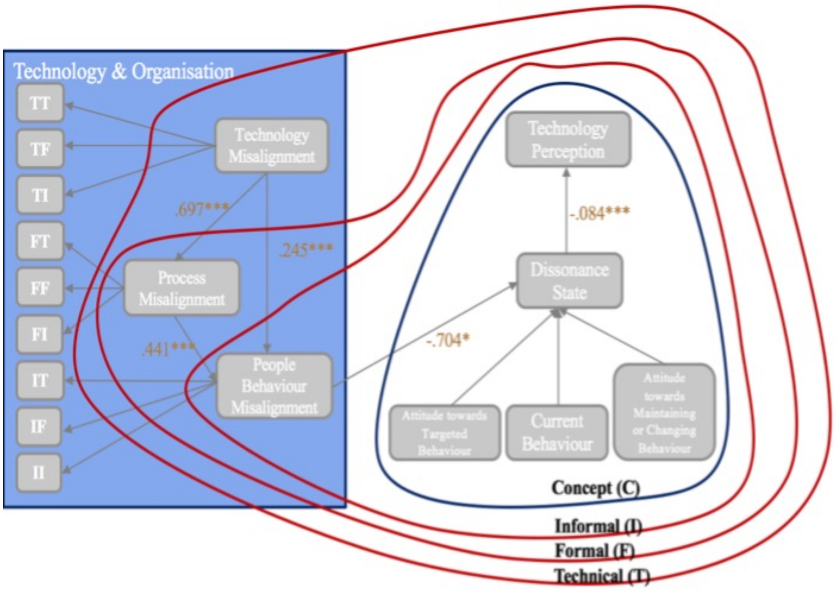


Figure 4.8. Nadee et al. (2017) proposed SEM Model.

Nadee et al. (2017) showed that the flow, when considering new technology innovation in industry, matched the layers and flow proposed in the dual-aspect model (see figure 4.8). Nadee et al. (2017) concluded that 'Systems implementation is a multi-dimensional complex problem. To progress beyond the pre-implementation stage, we must plan for alignment of external (new) and internal (old) systems. To achieve this we must either plan to change the internal system to align with the external, via BPR (Business Process Reengineering), or if impossible we need to customise the external system to fit into the existing internal system.

The dual aspect model (see figure 4.5 and 4.6) is arguably a simplified representation of results. For example, a significant / direct connection was identified in results between technical misalignment and behavioural misalignment, suggesting a direct connection between the technical an informal business activity, however this is not represented by concentric dependent circles (as used in the dual-aspect model). Despite criticisms, the dual-aspect model helps UG pre-experiences student when considering the conflict of systems – i.e., conflict that exists between both between different types of systems (people, organisations, and technology) and different types of norms. In my experience of teaching the dual-aspect model, students find it easy to understand, and useful for systematically considering possible issues that might exist at each of the nine conflict points (TT, TF, TI, FT, FF, II, IT, IF, II - see figure 4.6). It is particularly useful when discussing i) IT implementation – such as an ERP implementation – and issue of configuration / customisation / business process change, ii) company acquisitions and mergers, and/or iii) cultural conflicts.

4.2.2 Technology Acceptance

Acceptance is the action of consenting to receive or undertake something offered (Wannatawee, Alhammad and Gulliver, 2014). At an individual level, acceptance requires internal reasoning that the 'new' system or technology provides (on balance) some positive value. If a system is implemented successfully, yet the new system is not accepted and/or used, then it should be considered as a failure. Accordingly, it is important that UG pre-experienced students appreciate technology acceptance aspects.

Theories of Technology Acceptance

Information technology (IT) adoption is held by many as the primary measurement of IS successful, and serves as a benchmark of information systems success (Nedović-Budić and Godschalk, 1996). Social learning theory suggests that behaviour change is affected by three factors: personal factors, environmental factors, and behavioural attributes; as individuals learn behaviour through observation, direct experience, and discussion and interaction. People learn new attitudes and behaviour through observation, i.e., noting the positive and negative outcomes that occur because of actions (Fogg, 2003). Social learning theory, however, states that behavioural change, through social learning, can be achieved only if the positive expectations of the behaviour are greater than the negative ones. Accordingly, individuals should have self-efficacy – a belief in their capability to execute the new behaviour - and should have a level of motivation needed to undertake the action.

To understand the issue of behavioural change, several behavioural models have been created, by social psychologists, which have been used extensively in literature to predict IT adoption; and have been successfully proven to be effective in predicting intentions and usage (Yeo, 1996). These theories, which are discussed systematically in the MM258 module, often present 'behavioural intention' (e.g., Brown et al, 2002; Szajna, 1996) as the acceptance model outcome; since significant has proved that behavioural intention commonly leads to the individual performing the behaviour (e.g., Fishbein and Ajzen, 1975; Davies et al., 1989; Ajzen, 1991).

According to the Theory of Reasoned Action (TRA), a social-psychological/behavioural theory that has been widely used due to its value when understanding different behaviour (Fishbein and Ajzen, 1975), two primary factors are required to support positive behavioural intention: a persons' attitude to achieve targeted behaviour, and subjective norm within the social environment (Fishbein and Ajzen, 1975) – see figure 4.9.

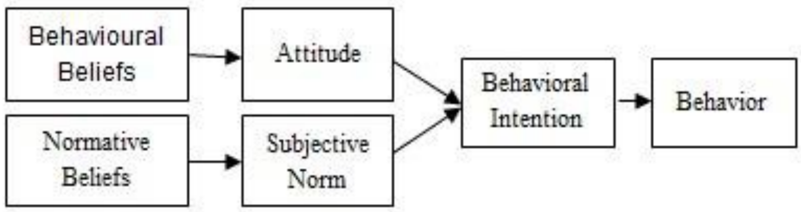


Figure 4.9. The basic Theory of Reasoned Action (TRA) model. (adapted from Venkatesh et al., 2003).

The Theory of Reasoned Action Model was expanded by Azjen (1991), to form the Theory of Planned Behaviour (TPB) – see figure 4.9. Initially Fishbein and Ajzen (1975) stated that the main determinate of behaviour execution is behavioural intention, which could be determined by evaluating individual's attitude toward behaviour and subjective norms, however later Ajzen (1991) recognised that performing most human behaviour is linked with individual's ability to perform such behaviour. Thus, he introduced the concept of perceived behavioural control in the TPB (see figure 4.10). This concept is similar to self-efficacy in the social cognitive theory and aims to control resources, skills, and opportunities that would support adopting such behaviour.

The TPB focuses on context-specific attitudes in forming behaviour (Fishbein and Ajzen, 1975, Ajzen 1991); thus, it predicts intention as opposed to behaviour (Kantowitz et al, 1996). When expanding the Theory of Reasoned Action, to include "perceived behavioural control" (Ajzen 1991) explained that "attitude is likely to predict behaviour when the attitude includes a specific behavioural intention, and the attitude is based on a first-hand experience". This theory has dominated information systems development and implementation until recently, when various versions and/or expansion were specifically derived for IT adoption (Bhattacherjee and Sanford, 2006; Wannatawee, Alhammad, and Gulliver, 2014).

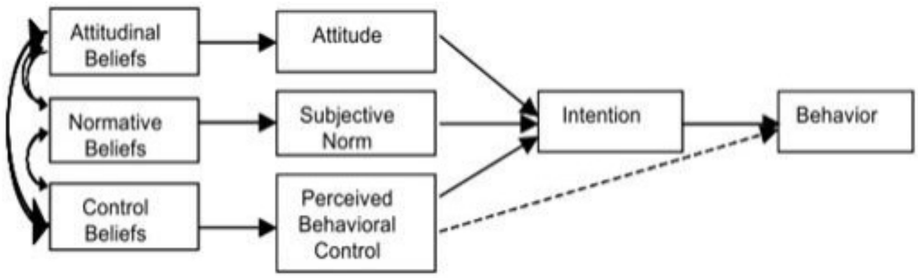


Figure 4.10. Theory of Planned Behaviour (adapted from Ajzen, 1991).

The Technology Acceptance Model (TAM), adapted from TPB (see figure 4.11), was designed for use in the context of IS, i.e., for the purpose of predicting information technology acceptance and usage in the work environment. The final conceptualisation of the TAM model includes two core constructs which are i) Perceived usefulness, i.e., "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davies et al., 1989), and ii) Perceived ease of use, i.e., "the degree to which a person believes that using a particular system would be free of effort" (Davies et al., 1989).

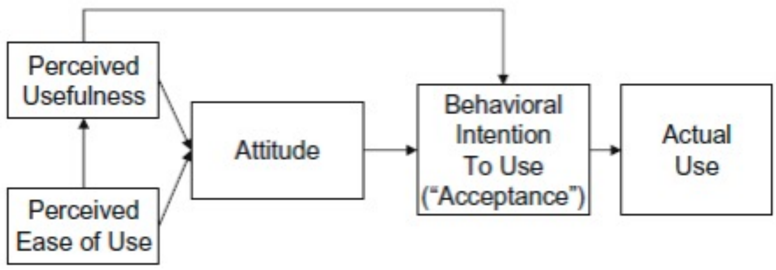


Figure 4.11. Technology Acceptance Model (adapted from Davies et al., 1989).

Accordingly, TAM identifies two factors: the perceived ease of use (PEOU) and perceived usefulness (PU); to determine an individuals' attitude (ATT), which influences individual's behavioural intention (Davies et al, 1989). The Technology Acceptance Model (TAM) is one technology acceptance theory that can be used to simply understand the perceived barriers and benefits of using information technology (Venkatesh and Davis, 2000). TAM has, over the duration of its use, helped to predict acceptance of information technology in numerous domains; with perceived usefulness supporting practitioners to identify where the benefits and the perceived benefits are defined and the second factor, i.e., perceived ease of use, acknowledging the effort required to gain the perceived gains from the first factor. In 2000 TAM2 was introduced, which removed ATT and added social influences (subjective norm, voluntariness, and image), cognitive instrumental processes (job relevance, output quality, result demonstrability), and perceived ease; that influence individuals (positively or negative) acceptance of IT (Venkatesh and Davis, 2000) – see figure 4.12. Unlike the original TAM model, TAM2 eliminates attitude but adds subjective norms; for the purpose of achieving a better explanation of the intention.

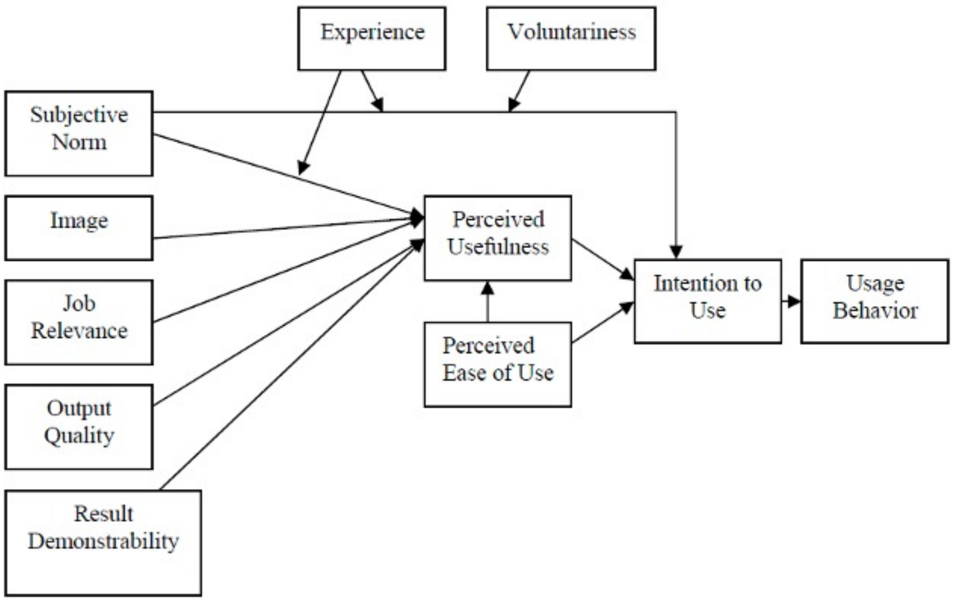


Figure 4.12. The Extended Technology Acceptance Model (TAM2).
(adapted from Venkatesh and Davis, 2000, pp. 188).

Venkatesh and Davis (2000) use the subjective norms construct to capture social influences. TAM2 suggests that in mandatory contexts (such as technology use at work), subjective norms have a direct effect on intention through the mechanism of compliance. Subjective norms are defined as a person's perception of what is most important to other people, i.e., the likely outcome of what the person will choose as the target behaviour (Venkatesh and Davis, 2000;

and Holden and Karsh, 2010). If an individual perceives that a important social actor has the ability to reward compliant behaviour, or punish non-compliant behaviour, the effect of social influence compliance becomes significant (Venkatesh and Davis, 2000). In voluntary contexts, social influences can influence intention indirectly through the mechanism of internalisation and identification. Internalisation refers to the process when an individual incorporates the important referent's belief into his or her own belief structure. Identification means that an individual can gain a membership in a social group or achieve a higher status within the group by performing the target behaviour.

TAM2 (Venkatesh and Davis, 2000) theorises that there are four instrumental determinants of perceived usefulness, i.e., job relevance, output quality, result demonstrability, and perceived ease of use. TAM2 retains perceived ease of use from TAM as a direct determinant of perceived usefulness (see figure 4.12). TAM2 theorises that "people use a mental representation for assessing the match between important work goals and the consequences of performing the act of using a system as a basis for forming judgments about the use-performance contingency (i.e., perceived usefulness)" (pp.191). Based on theories of mental matching processes, a potential user's judgment of job relevance goes through a compatibility test (Venkatesh and Davis, 2000). Job relevance is defined as "an individual's perception regarding the degree to which the target system is applicable to his or her job" (pp.191). TAM2 posits that job relevance has a positive effect on perceived usefulness. Output quality is another determinant of perceived usefulness. Output quality refers to an individual's perception about how well the system performs the tasks. Venkatesh and Davis (2000) suggest that judgments of output quality take the form of a profitability test, "in which, given a choice set containing multiple relevant systems, one would be inclined to choose a system that delivers the highest output quality" (pp.192). TAM2 posits that output quality has a positive effect on perceived usefulness. Result demonstrability is the third determinant of perceived usefulness. TAM2 posits that result demonstrability has a positive effect on perceived usefulness.

Another theory that helps our understanding of new technology adoption and usage is the Motivational Model (MM), as significantly supported by Davies et al. (1992) and Venkatesh and Speier (1999) - see figure 4.13. The MM introduced two variables that influence individual's intention; i.e., extrinsic motivation (EM) and intrinsic motivation (IM). EM is similar to Perceived Usefulness (Davies et al, 1989), and IM is similar to use attitude (ATT) in the TPB model (Venkatesh et al., 2003).

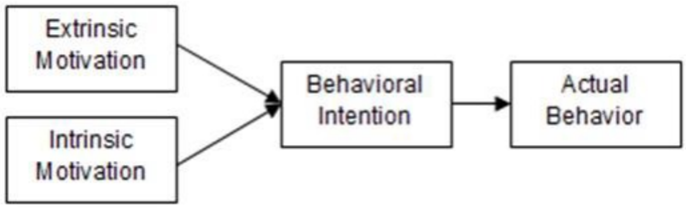


Figure 4.13. Motivational Model (adapted from Davies et al., 1989).

Venkatesh et al. (2003) formulated a new model called the Unified Theory of Acceptance and Use of Technology (UTAUT). The Unified Theory of Acceptance and Use of Technology (UTAUT), considered studies reviewing and testing all significant technology acceptance models and theories. They incorporated constructs from eight different models (including TRA, TPB, TAM, TAM2, MM). UTAUT presents three constructs as determinants of intention to use an information technology. These are defined as performance expectancy (converted from PU), effort expectancy (from PEOU), and social influence (adapted from social norms). Performance expectancy is defined as "the degree to which the user expects that using the system will help him or her attain gains in job performance" (pp. 447). This construct has five root constructs: perceived usefulness (from TAM/TAM2, Combined TAM and TPB), extrinsic motivation (from the Motivational Model), relative advantage (from the Innovation Diffusion Theory), and outcome expectations (from the Social Cognitive Theory). Effort expectancy is described as "the degree of ease associated with the use of the system" (pp. 450). Social influence is portrayed as "the degree to which an individual perceives that important others believe that he or she should use the new system" (pp. 451). Venkatesh et al. also added facilitating conditions, which they defined as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (pp. 453); and included question items from TPB. The UTAUT model introduced four moderators that influence perception of the main constructs in the model, which were: gender, age, experience, and voluntariness of use (see figure 4.14), however found facilitating conditions is only moderated by age and experience of the individual.

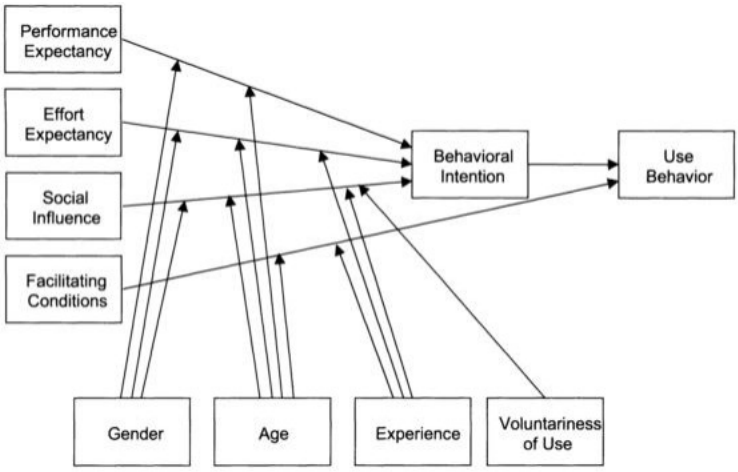


Figure 4.14. Unified Theory of Acceptance and Use of Technology.
(Adapted from Venkatesh et al., 2003)

Within a new model called UTAUT2, the UTAUT model was expanded (Venkatesh et al., 2012), with three new constructs, i.e., hedonic motivation (HM), price value (PV), and habit (HB) – see figure 4.15, to consider the context of consumers. Because of this new context, moderators used in the UTAUT model were amended as voluntariness of use was not considered contextually relevant.

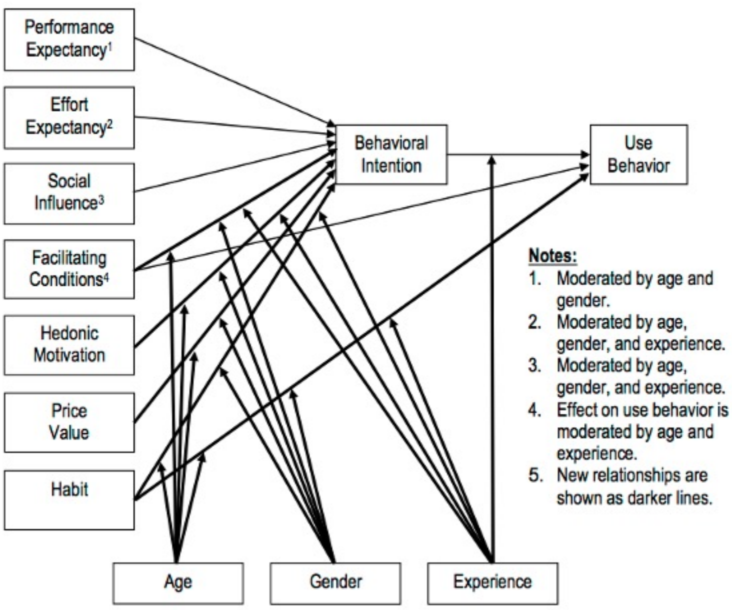


Figure 4.15. UTAUT2 model
(adapted from Venkatesh et al. 2012).

Table 4.5. Technology Acceptance Factors, Definitions, and Contextual Consideration. (adapted from Wannatawee, Alhammad and Gulliver, 2014).

Constructs	Definitions	Models including constructs
Attitude Towards Behaviour	"an individual's positive or negative feelings about performing the target behaviour" (Fishbein and Ajzen, 1975)	TRA/TPB/TAM
Subjective Norm (SN)	"the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein and Ajzen, 1975)	TRA/TPB/ TAM2
Perceived Behavioural Control	"the perceived ease or difficulty of performing the behaviour" (Ajzen, 1991)	TPB
Perceived Usefulness	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davies et al., 1989)	TAM/TAM2
Perceived Ease of Use (PEOU)	"the degree to which a person believes that using a particular system would be free of effort" (Davies et al., 1989)	TAM/TAM2
Extrinsic Motivation	The perception that users want to perform the behaviour because "it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davies et al., 1992)	MM
Intrinsic Motivation	The perception that users want to perform the behaviour "for no apparent reinforcement other than the process of performing the activity per se" (Davies et al., 1992)	MM
Performance Expectancy (PE)	(See PU)	UTAUT/ UTAUT2
Effort Expectancy (EE)	(See PEOU)	UTAUT/ UTAUT2
Social Influence (SI)	(See SN)	UTAUT/ UTAUT2
Facilitating Conditions (FC)	(See PBC)	UTAUT/ UTAUT2
Behavioural beliefs	An individual's perceptions about specific positive/negative outcomes of performing the target behaviour	TRA/TPB
Normative beliefs	specific groups or people who encourage/discourage the behaviour	TRA/TPB
Control beliefs	specific factors or circumstances that make behaviour easier/more difficult	TPB
Hedonic Motivation (HM)	Users perceptions of the fun or pleasure derived from using a technology (Venkatesh et al. 2012)	UTAUT2
Price Value	The cost and pricing structure of using a new IT (Venkatesh et al. 2012)	UTAUT2
Habit	The extent to which people tend to perform behaviours automatically because of learning (Venkatesh et al. 2012)	UTAUT2

Identifying the factors influencing individual behavioural intention is one of the continuing issues critical to the IS field (King and He, 2006). As such the UTAUT2 model is critically presented to UG pre-experience students, within the MM258 module, to allow students to discuss i) the balance between benefit/effort, ii) the impact of social influence, resource availability (facilitating conditions), and enjoyment (hedonic motivation) on technology behavioural intention and use, and iii) the significant (and often automatic) impact that habit can have on user behaviour – irrelevant of behavioural intention.

Table 4.5 provides a summary of technology acceptance factors, their definition, and how these have been considered within various models/theories of user acceptance.

4.2.3. IS Failure – Pankratz and Basten (2013)

Pankratz and Basten, as also described introduced in section 2.3, reviewed leading IS publications as a starting point for consideration of IS failure case selection. The journals and periodicals used within this study can be identified in appendix A1 (table A1). Pankratz and Basten considered papers containing information systems case descriptions, and independently judged each to determine whether it should be considered within analysis. To be included in the study, the paper required a full description of the project failure, and reasons should be expounded for the reasons leading to the failure. Where Pankratz and Basten disagreed with other the article was excluded from consideration. In total 15 cases were presented across 17 articles (see table 2.1). Failure examples represent a range of cases (between 1978 and 2009). It is worthy of note, however, that i) journals were taken from a range of sources that represent the best in information systems research and ii) reflect significant contributions from some of the best information systems researchers from the last 30 years.

Pankratz and Basten conducted a systematic literature review of 15 IS failure case studies, and, using thematic analysis, proposed 54 distinct failure factors (see appendix A), which they mapped within a theoretical multi-dimensional model consisting of 10 categories (i.e. conditions, directive decisions, insufficient consideration of customer, project planning, project management, change management, top management attitude, customers-contractual relationship, technology, and unexpected events) and 8 dimensions (i.e. time, cost, quality, process efficiency, satisfaction with the process, strategic goals, end-user needs, and satisfaction with product). Allocation of themes failure factors are:

1) **Conditions** that are present at project initiation (i.e., 4 factors - a lack of clear responsibility concerning IT, high system complexity, a climate of mistrust, and unclear strategic goals) – see Appendix A1 table A4.

2) **Incorrect directive decisions** that impact project course (i.e., 5 factors – requirements not regulated contractually, lack of acceptance criteria, insufficient contractor experience, prolonged contracted competition, and replacement of the contractor) – see Appendix A1 table A5.

3) **Insufficient consideration of the customer** (i.e., 5 factors - system does not fit culture of customer organisation, inappropriate development approach, system does not seek customers strategic goals, requirement discrepancies amongst user groups not considered, and developers lack of understanding concerning user needs) – see Appendix A1 table A6.

4) **Inappropriate or poor project planning** (i.e., 5 factors unclear project goals, false business case, lack of time planning, underestimation of effort, and lack of overall IS plan) – see Appendix A1 table A7.

5) **Project management factors** (i.e., 9 factors - inexperienced project manager, inadequate requirements specification, development approach not understood, project management method applied incorrectly, ineffective communication, loose control, prolonged development, management forces fudging status reports, and insufficient quality assurance) – see Appendix A1 table A8.

6) **Poor change management** (i.e., 8 factors - users lack of experience in using IT, changes in traditional routines and practises redistribution of power, insufficient stakeholder involvement, low morale of end users, inadequate training, limited prestige and status of project champions, disregarding different perceptions of stakeholders, and IT is considered as a magic bullet) – see Appendix A1 table A9.

7) **Poor top management attitude** (i.e., 5 factors - insufficient top management commitment, decision frame of key decision makers influenced by prior successes, stakeholders responsible for project not open for problems / criticism, disregarding external advice, and ignoring alternative solutions) – see Appendix A1 table A10.

8) **Inappropriate consumer contractor relationships** (i.e., 4 factors - uncooperative relationship between customer and contractor, too much trusting contractor, too much pressure on contractor, and too little accountability demanded from contractor) – see Appendix A1 table A11.

9) **Technology issues** (i.e., 4 factors - technical problems, limited technology, technological uncertainty, and poor system quality) – see Appendix A1 table A12.

10) **Unexpected events** (i.e., 4 factors - knew legal regulations, key staff changes, late changes of requirements, and supplier delays) – see Appendix A1 table A13.

For each of the 54 defined failure factors, Pankratz and Basten linked one or more relevant stakeholders, i.e., End-users, Sponsors, Top management, Customer, Contractor, Requirement specialist, Software engineers, Tests, Portfolio / program management, Project management officer / project manager, Team members, Suppliers, Project, Regulators – see Appendix A1 table A2 for a full description of stakeholder.

So, for example, the 'lack of clear responsibility for IT' factor, in the conditions category (defined as "a lack of single entity responsibility for IT that leads to objective conflicts an absence of a clear strategic vision"), identified from case 5 (i.e. IS to automate processes of manual dispatch systems associated with ambulance services in the UK) was found to impact stakeholder TM (i.e., top management), and impact failure dimension number 6 (i.e., the project goal). This level of mapping is done for all 54 failure factors. Some failure factors, however, link to multiple sources, multiple failure dimensions, and/or multiple stakeholders. As such, although model presents an extensive and comprehensive model of information systems failure, it is quite confusing to present, and quite complex for students to assimilate in the limited seminar sessions.

Appreciating an appropriate level the complexity is important to support M258 students understanding that success is not a one-dimensional dichotomy – i.e., success / failure; and that the outcome of a project is subject, depending on the perspective and horizon of the stakeholders involved. Currently in MM258, students are not expected to remember the detail of the model, and are encourage, at a basic level, recognise the key failure dimensions and categories.

4.3. Research Data Collection

To answer research question 1, which asks "Do MM258 students understand the systems models currently being taught to them?", it is essential to present the models to a large sample of undergraduate pre-experience students, and capture and analyse information to determine student understanding. Assessing the understanding of students will facilitate the selection of a kernel model, which will be used, supported by design science, to investigate research question 2, which asks “Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?”. In this section I will elaborate the design of the MM258 seminars used to collect data from students.

4.3.1. Designing Seminar Sessions

Real-world MM258 seminar sessions were used to capture student data within a contextually appropriate setting. Although the use of seminars limits the quantity, and arguably the quantity, of data that can be captured from participants - due to the primary focus of the seminar session being focused on the education of students, and not on the capture of DBA data. Use of real-world seminars ensured that data was collected in a contextually relevant teaching environment, and that students were presented with an introduction to each model that accurately reflected undergraduate information systems modules teaching (as this is what was happening).

Since data capture questions were incorporated as part of interactive sessions (description of each seminar is presented in detail in Appendix B). It was essential that feedback could be presented back to students to support personal reflection, which students were encouraged to use (individual and in group discussion) to support session and coursework discussion. I investigated a number of questionnaire technologies, e.g., Google forms, Survey Monkey, Qualtrics, to identify a tool that would facilitate automatic generation of feedback to students, yet the tools considered were not able to provide students with complex feedback, which was seen as essential to support the subsequent reflection of student.

Accordingly, I developed a web environment, using PHP, with a simple front end (see figure 4.16), to allow controlled capture and feedback of session data. Code was specifically designed to work on both laptops and phones to maximise access options and ensure equity. Once a student logged in, using their student e-mail, the student was able to select (from the front page) the relevant seminar section, and answering questions as the seminar progressed. Functionality therefore included: student log in, completion of relevant questions, provision of instant feedback to support class-based discussion, and presentation of results (after the session) – i.e., to support subsequent personal and group reflection in support of coursework.

Figure 4.16. Online Questionnaire front page.

The four sessions were designed to support students in consideration of the MM258, yet also support DBA data. In the following sections, I will describe how this paradox was managed.

Introduction Seminar – Introduction to the Coursework Scenario

In the first seminar (see coursework scenario in Appendix B1 and seminar slides in Appendix B2) students were introduced to the coursework scenario (adapted from Sumner, 2007), which was used in subsequent seminars to facilitate presentation of the information system models, and classroom discussion. This scenario presents an example of an US-based family-owned distributor of office equipment called Bandon Group Inc., who initially developed their own information systems, yet later purchased two off the shelf solutions. Unfortunately, the off-the-shelf solutions were purchased without consideration of future integration and/or detailed consideration of future business needs. As such the IT department spent nearly ten years transferring data between the operational system and the sales system and developing functional bolt-on to augment the sales system with the CRM functionality that they needed to operate effectively (see appendix B1 for full description). The coursework required the students to understand the basic business and, taking on the role of a consultant, consider the feasibility of implementation of enterprise system solution within Bandon. The use of a single coursework scenario provided students with a consistent context and focus; i.e., all questions in subsequent seminars were placed in context of the same scenario, ensuring that all students were clearly aware of the context of reference. Moreover, since the scenario was integral to the assessment of the MM258 module, it was of critical importance that all students understood the Bandon coursework scenario in detail; something that would not be possible if data collection had been done outside the context of real-world teaching.

In the introduction seminar, students were also encouraged to login to the developed online web system - available at http://www.stephenrgulliver.online/bandon/FrontPage.php. The reader is welcome to login to this system using stephengulliver@hotmail.com, as a token email login, however questions used in the DBA are no longer available on the live system. When students first login to the system, all students were asked to i) read the information sheet and indicate if they objected to their data being anonymously used in university research, and ii) provide some basic demographic information (see Appendix B2), i.e. to determine age, gender, area of study, and/or determine whether the student was pre- or post-experience in nature.

Content Seminar 1 – Introduction to System Conflict (Winai et al. Model)

Students were asked to read the Nadee et al. (2017) paper in advance of seminar 1, however as many students do not effectively prepare for sessions, students were also given i) a short time in the session to read the paper and highlight what they thought were key issues, and ii) a summary introduction to the dual-aspect model. See Appendix B3 for detail concerning seminar slides, seminar process, and PhP sample that supports automated student feedback.

Nadee et al.'s model, as described in detail in 4.2.1, defines nine cross-over / conflict points TT, TF, TI, FT, FF, FI, IT, IF, II. The letter on the left represents the new system aspect, the letter on the right represents the old system aspect. Informal (I) represents the system intention, e.g., the strategy that the system uses. Formal (F) represents the formalised plan used in the system, which have been developed in the system to achieve the informal (e.g., the rules and processes). Technical (T) represents the tools used and the application of the formal (e.g., the technology solutions chosen, or the business language used). If a technical issue (e.g., the interface language) in the new system conflicts with some technical issue in the old system e.g., the language of staff, then then is a TT conflict occurs.

Alignment is achieved if technical, formal, and informal norm alignment can be achieved; yet alignment can only be achieved by either i) changing the existing system – suggesting positive intention to change, ii) adapting and/or using the new system to support existing practice – suggesting a negative intention to change, or iii) replacing both systems. The dual-aspect model allows students to critically consider system interaction, and (in context of the Bandon scenario) allowed students to consider critically where conflict might exist if Bandon (the old system) were to try to align with an enterprise ERP system (the new system).

Since the primary focus of the seminar was to supporting MM258 student education, a range of questions were used in the seminar that were use in the DBA analysis (see appendix B3). The limitation of collecting data in a live seminar was most impacted in seminar 1. To assess whether students, in context of the case scenario, were positive or negative to the intention of change, students were asked to assess their agreement using an adapted version of the Winai Nadee's eight statements, as described in detail in 4.2.1, with a 5-point likert scale. Each statement was designed to capture the attitude towards change of a specific aspect of change, i.e., in the new or old system. Tx question represents a positive intention to change the new technical structure to fit with the existing system. Fx represents a positive intention to change the new processes and formal rule to fit with the existing system. Ix represents a positive intention to change the new system purpose / functionality scope to fit with the existing system. xT represents a positive intention to change the old technical structure to align with the new system. xF represents a positive intention to change in the old technical processes and formal rule to align with the new system. xI represents a positive intention to change the old system purpose / functionality scope to align with the new system. The adapted eight questions used were:

Q1. Bandon should use the ERP/CRM in all divisions
(represents a positive intention to change and adopt of the new system)

Q2. The new ERP/CRM will need to be customised to ensure it satisfies Bandon's needs
(represents Tx)

Q3. Bandon's existing technology needs to be customised, within each division, to be compatible with the ERP/CRM technology
(represents xT)

Q4. The ERP/CRM processes need to be changed to fit with the Bandon's current business processes.
(represents Fx)

Q5. Bandon's existing processes need be changed to support the new ERP process
(represents xF)

Q6. People will need to change their way of working if the ERP/CRM technology is adopted in place
(represents xI)

Q7. Interaction technology should be customised to minimise the impact on people's behaviour

(represents Ix)

Q8. Staff in Bandon won't want to use the new ERP/CRM technology at all

(represents a negative intention to change).

To determine whether students were positively or negatively to the use of ERP features within Bandon, instant feedback of each statement was calculated using the Kano's evaluation table (Table 4.6). For a technical description of this mapping see appendix B3.

Table 4.6. Kano's Evaluation Table.

Customer Requirements		**Dysfunctional (negative) question**				
		1. I like it	2. I expect it	3.I'm neutral	4. I can tolerate it	5. I dislike it
Functional (positive) question	1. I like it	Q	A	A	A	O
	2. I expect it	R	I	I	I	M
	3. I'm neutral	R	I	I	I	M
	4. I can tolerate it	R	I	I	I	M
	5. I dislike it	R	R	R	R	Q
A: Attractive, **O:** One-dimensional, **M:** Must-be, **I:** Indifferent, **R:** Reversal, **Q:** Questionable						

The nine interaction points, as defined by Winai Nadee, were calculated for the DBA research by combining the two question scores linked to that conflict state. Accordingly, the following equations were used:

$TI = $statements[2] + $statements[6]

$TF = $statements[2] + $statements[5]

$TT = $statements[2] + $statements[3]

$FT = $statements[4] + $statements[3]

$IT = $statements[7] + $statements[3]

$FI = $statements[4] + $statements[6]

$FF = $statements[4] + $statements[5]

$IF = $statements[7] + $statements[5]

$II = $statements[7] + $statements[6]

Although very limited in nature this data was able determine whether or not students are positive about change, with either i) higher score on the left, i.e., IT, IF, FT representing more focus on change of the old to support the new, or ii) higher score on the right, i.e. TI, IF, and

TF representing more focus on change of the new to support the old. States TT, FF, and II represent the interaction of respectively technical, formal, and informal norms in the two systems. If data analysis shows i) consideration between T, F, and I layers within systems, and ii) consideration between TT, FF, and potentially II between systems then it is clear that students have understood the key issues being considered in the Nadee et al. model.

Content Seminar 2 – Technology Acceptance

Within seminar 2, students were presented with the idea of technology acceptance – i.e., the idea that if users do not intend to use the system, and / or do not use the system, then the system implementation should be considered as a failure. In context all the Bandon scenario students were presented with several acceptance models (as described in detail in 4.2.2) to highlight the literature states that acceptance of technology was influenced by a range of factors. Students were asked to read the Venkatesh et al. (2012) paper in advance of the seminar, yet due to its length and assuming that some students did not complete this, the lecturer presented an introduction to the theory of reasoned action, technology acceptance model, and theory of planned behaviour, and the UTAUT2 model - which consists of seven factors (i.e., PE - performance expectancy, EE - effort expectancy, SI - social influence, FC - facilitating condition, HM - hedonic motivation, PV - price value, and HB - Habit). Students were then asked to consider whether they thought Bandon would be, as an organisation, impacted by each of the factors. Since context of the seminar related to Bandon's possible acceptance of an enterprise system – i) conjecture, and ii) not an individual - and because both Bandon and/or MM258 students had not previously used enterprise systems use, use of the original survey items, described by Venkatesh et al. (2012), was not possible. The ideal question survey, presented in the Venkatesh et al. paper, were developed to load with high reliability, however, were also developed to consider individual accepting of technology (if interaction with the technology already existed). For example, an adapted version of the original survey item EE3 would read 'I find Enterprise Systems easy to use', yet this is of limited value to support appreciation of the UTAUT2 factors, or support student reflection, in the MM258 seminar since no students completing the MM258 module have ever used an enterprise system. As such an alternative set of questions were developed, with the primary focus of supporting student discussion, reflection, and consideration of acceptance factors. Questions covered PP (including perceived benefits of technology capability, improvements to business process, business model, profit, turnover, customer satisfaction, etc.), EE (including the perceived level of effort involved in technology change, process, change, business model change, with consideration of KPI including cost, time, etc.), SI (including the impact of external and internal stakeholders, e.g. management at all levels, customer, suppliers, competitors, etc.), FC (including consideration of all required resource, both in context technology, processes, skills, and infrastructure), HM (including consideration of whether a range of individuals are likely to enjoy using the technology), PV (considering the perspectives of a number of stakeholders), and Habit (considering the perspectives of management, staff, customers and suppliers). For full details of the questions, please see B4. All questions used a 5-point Likert scale. Instant feedback was provided to students, via the developed web system, providing students with a single average score (1-5) for each of the seven factors. Once students had individually answered questions, and got the average for each of the factors, student were put into groups and encouraged to critically consider which factors were most relevant to the coursework example.

Due to our not being able to use the original UTAUT2 questions, I would expect a reasonable level of cross-loading in results. Given time, it might be possible to develop a set of question items, which could be used in the seminar that, as well as considering UTAUT2 questions, also support effective consideration of the factors being considered currently in the seminar, e.g., stakeholder impact, impact on technology, process, business model, etc. yet development of such as instrument is not the intention of this study. The aim of data capture is not too identify a perfectly loading set of question items for UTAUT2 from an organisational perspective, but to i) primarily support student education, and ii) demonstrate at a basic level that students understand the core issues being discussed; with the hope that loading occurs within either UTAUT2 factors (e.g. all PE questions loading together) and/or stakeholder involvement (e.g. questions about customers -across factors- loading together). If results identify loading that loosely represents the UTAUT2 then, due to the untested nature of questions, this will demonstrate that student understanding of the UTAUT2 model is good.

Content Seminar 3 – Pankratz and Basten

Within seminar 3 students were introduced to the area of information systems failure, by introducing students to the Pankratz and Basten (2013) study. Students were asked to read the Pankratz and Basten (2013) paper in advance of the seminar, however since many students do not effectively prepare for sessions, students were also provided a brief summary of the steps taken by Pankratz and Basten (see appendix B5). Each of the categories in turn were presented to the students, however only a limited description of each failure factor was possible; duty the high number of factors involved.

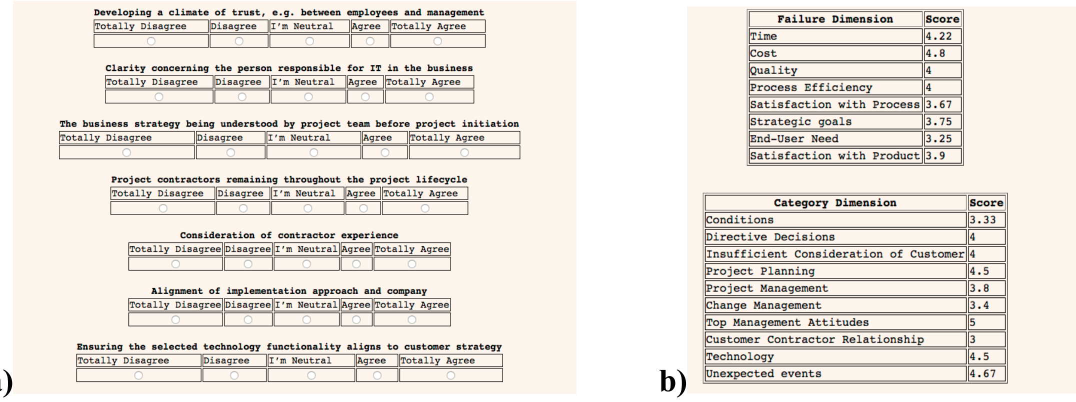
To determine if students had understood the model, 26 questions were developed (see appendix B5). One question was developed for each selected factor. Factors we selected to ensure a coverage of failure dimensions (i.e. with between 5 and 9 factors mapping in Pankratz and Basten failure dimensions) – see table 4.7 - and a fair allocation across failure categories (FC); with category 1 represented by 3 questions, category 2 represented by 2 questions, category 3 represented by 2 questions, category 4 represented by 2 questions, category 5 represented by 5, category 6 represented by 5 questions, category just 7 represented by 1 question, category 8 represented by just 1 question, category 9 represented by 2 questions, and category 10 represented by 3 questions. Specific categories with more factors (particularly project management) were allocated more questions. For full details of seminar slides, and question items, used in seminar 3, then see appendix B5.

Feedback was provided by students on a 5 point Likert scale (1- unimportant, 2 – slightly unimportant, 3 – not sure, 4 – slightly important, 5 – totally important) – see figure 4.17a. The average scores linked to specific failure dimensions and failure categories (see table 4.7) was automatically calculated by developed web system, and presented back to students (see figure 4.17b).

Although ideally students would be asked multiple questions about each failure factor, i.e., to allow the removal of all cross-loading variables, this is practically impossible in context of a real-world similar scenario. Due to the high number of factors, i.e., 54, it is unreasonable to expect students to answer the number of questions required to support clean modelling. Accordingly, a low number of questions was used, which allowes students to critically discuss the issues in class but providing an indication whether students understand the Panratz and Basten model. As such I expect that results will not load perfectly, and/or allow reliably modelling and validation of the Pankratz and Basten model – as this is not the point of this study – but hope to see some loading either across specific categories or dimensions, i.e., all questions for specific categories or dimensions loading together. If principal component analysis loadings show some preference loading of categories and/or dimensions this this will demonstrate a basic understanding of students.

Table 4.7. Pankratz and. Basten Matrix, developed to reduce the length of data collection.

	Failure Dimension (FD)								
Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**CAT**
1. Climate of mistrust with customer organisation				4	5				1
2. Lack clear responsibility of IT						6			1
3. Unclear strategic goals						6	7	8	1
4. Replacement of the contractor	1								2
5. Insufficient contractor experience			3						2
6. Develop approach not understood				4					3
7. System does not suit						6	7	8	3
8. Understanding of Effort	1	2			5				4
9. False business case						6			4
10. Management status report	1	2			5				5
11. Inappropriate development approach	1	2		4					5
12. Loose Project control				4		6	7	8	5
13. Project Management Method			3	4	5				5
14. Inadequate requirements specification			3				7	8	5
15. Users lack of using IT							7	8	6
16. Redistribution of Power							7		6
17. It consider a magic bullet							7	8	6
18. Limited prestige								8	6
19 Disregarding difference perception								8	6
20. Ignoring alternative solutions	1	2	3						7
21. Too little accountability demanded from contractor	1				5				8
22. Poor system quality			3					8	9
23. Technological uncertainty						6			9
24. Key staff changes	1		3	4					10
25. New Legal regulations						6			10
26. Late changes of requirement	1	2	3						10
No OF FD	8	5	7	6	5	7	7	9	



Failure Dimension	Score
Time	4.22
Cost	4.8
Quality	4
Process Efficiency	4
Satisfaction with Process	3.67
Strategic goals	3.75
End-User Need	3.25
Satisfaction with Product	3.9

Category Dimension	Score
Conditions	3.33
Directive Decisions	4
Insufficient Consideration of Customer	4
Project Planning	4.5
Project Management	3.8
Change Management	3.4
Top Management Attitudes	5
Customer Contractor Relationship	3
Technology	4.5
Unexpected events	4.67

Figure 4.17. Pankratz and Basten question (online) and student feedback.

4.3.2. Sample and Data Cleaning

MM258 students represent the desired population, i.e., UG pre-experience students learning about IS, however it was critical that relevant checks were taken to prevent issues of bias being captured within the data. To complete admission onto the Henley degree, all MM258 students (in China or UK) had to satisfy strict academic and language checks (see section 2.1). In the autumn of 2015, and in the spring of 2016, the data collection approach was developed, checked, and awarded ethical approval (within the School of Business Informatics, Systems, and Accounting, Henley Business School). Capture of data occurred in MM258 seminars between September 2016 and April 2019. The MM258 module are taught in China, at the Beijing Institute of Technology (BIT), between September and December (with a cohort of approximately 140), and in the UK (at the University of Reading), between January and April (with a cohort of about 100). The online web environment, slides, and step-by-step instructions were developed – see appendix B. Since I was not allowed to remotely run the sessions in China (a condition in the agreement between the University of Reading and BIT), a video was created for each seminar to clearly explain how each session should be run by local lecturers. Moreover, for all overseas sessions i) a meeting was held with the local lecturer prior to each session to ensure that all issues were considered, and ii) I was available online at the time of the seminar in case there was a technical issue – such as minor issues with students trying to login to the online with the wrong email address. To measure the possible impact of individual, cultural, and teaching differences, a number of additional tests were added to the MM258 experience: 1) when students were initially asked to log into the online system, a number of questions capture independent information about the student profile (e.g. gender, nationality, country of residence / study, number of years of work in industry), which was kept securely and linked (using codes) to the each student profile; 2) within the human systems lecture, each student was encouraged to complete, and reflect on the results of: i) a 44 question Big Five personality test (John and Srivastava, 1999); ii) the CVScale individual cultural value scale (CVScale) test (Yoo et al, 2011), which aims to measure Hofstede's five cultural dimensions (Uncertainty Avoidance {Un Av}, Power Distance {Po Di}, Masculinity/Femininity {Masc}, Individualism/Collectivism {Coll} and Long term/Short term Orientation {LTO}) at the individual level; and iii) for 2016-17 and 2017-18 cohorts, I was also lucky enough to acquired licenses (from Belbin - https://www.belbin.com/) to test student team role preferences. The first two tests were added to the online website (see Figure 4.16). The Belbin test, however, required students to enter the Belbin's hosted systems, as Belbin were unwilling to provide information about how scores were created, but i) each student received a personalised report (see figure 4.18 example) to support student personal reflection, and ii) I received a percentage based feedback how each student mapped to each role (resource investigator{RI}, teamworker {TW}, co-ordinator{CO}, plant {PL}, monitor evaluator {ME}, specialist {SP}, shaper {SH}, implementer {IMP}, completer finisher {CF}).

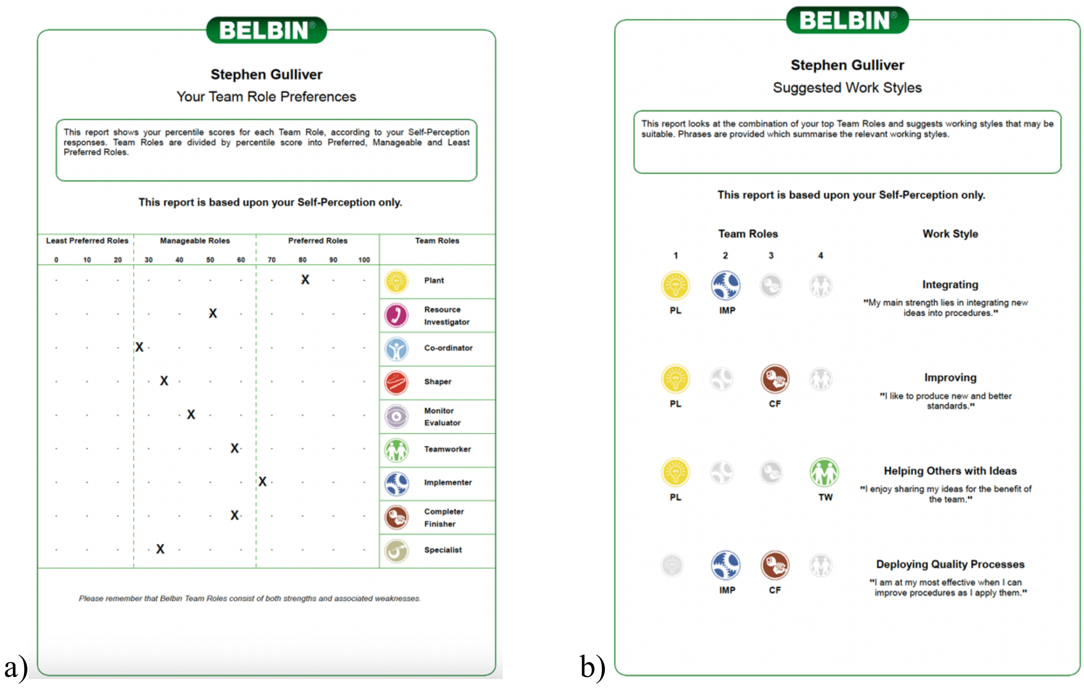


Figure 4.18. Example Belbin report a) Team Role Preferences and b) Working Styles

In total, data was collected from 581 MM258 students. Data was collected from four MM258 cohorts (2 from China and 2 in UK). Several students requested that their data be removed from analysis. This was done, without any questions, in line with participant wishes and ethical conditions. Moreover, several students were absent from specific seminar sessions and/or had minor technical problems that prevented the student from submitting the data online. To ensure consistency in the sample, all students with incomplete datasets were removed from the analysis dataset. In total 384 full data sets were considered (231 Females and 153 Males).

Statistical analysis was used to compare whether any differences in seminar question answers occurred as a result of gender, country of residence, cohort, nationality, personality, experience, and individual difference. The density curves and Q-Q plots (see example in figure 4.19) for each of the Belbin team scores showed that scores (determined by Belbin) are not distributed normally.

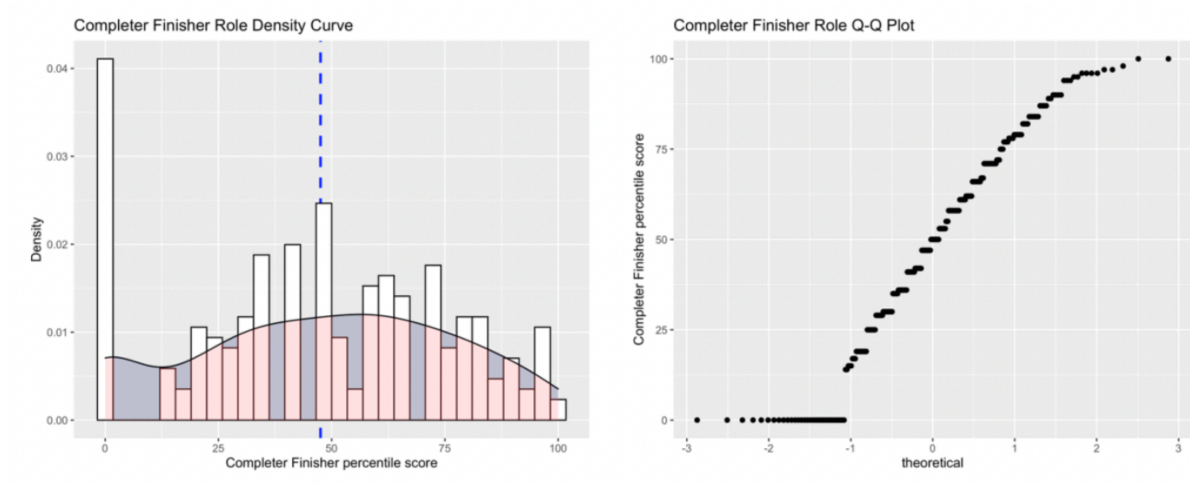


Figure 4.19. Example density curves and Q-Q plots for Belbin Team Roles.

Correlations were found between Belbin team roles, and personality and individual cultural value scale (CVscale) constructs (see table 4.8). These correlations suggests, that some overlapping occurs between personality, CVscale, and Belbin factor construct. This is not surprising as each of these test measure individual difference. No significance, however, occurred in either i) the answering of seminar questions, or ii) the distribution of individual factors as a result of country of residence, or nationality. Gender did impact student ME (i.e., Masculitity) scores, which also correlated with extroversion scores, but this impacted was consistent in both cohorts (China and UK).

Results suggests i) that there is a good mix of individuals in the MM258 dataset, and ii) that neither collection of individual level data, or student feedback to seminar questions, is significantly impacted by country of residence, cohort, or nationality.

Table 4.8. Correlation between statistically significant relationships of building team roles and the personality and cultural value dimensions.

	PL	RI	CO	SH	ME	TW	IMP	CF	SP
Neuro						-0.14			
Open	0.41	0.19	0.15	0.11		-0.31	-0.21		
Agree	-0.14						0.20	0.15	
Cons		-0.27				-0.16	0.24	0.20	
Ext		0.24	0.23	0.23	-0.26		-0.18	-0.16	
Un Av							0.13	0.16	
Masc	0.15								
Coll			0.13						
Po Di	0.17								
LTO									-0.17

4.4. Model Analysis

In sections 4.4.1 to 4.4.3 collected data the research will assess: i) what students understood, from MM258 seminar sessions, i.e., concerning specific taught information systems models, and ii) whether students are able to distinguish the complexities of specific models (with consideration for the weaknesses highlighted concerning data collection). The aim this session is to answer research question 1, which asks "Do students MM258 understand the systems models currently being taught to them?". Assessing the understanding of students will facilitate the selection of a kernel model (see section 4.5), which will be used, supported by design science, in chapters 5 and 6 to investigate research question 2, which asks "Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?"

Accordingly, the following three subsections analyse in turn data collected from MM258 student feedback from taught seminar sessions (over 4 consecutive cohorts) relating to respectively i) the dual aspect model (Nadee et al., 2017) – in section 4.4.1, ii) UTAUT2 (Venkatesh at al., 2012) – in section 4.4.2, and iii) the failure constructs defined by Pankratz and Basten (2013) – in section 4.3.

4.4.1. Dual Aspect Model

Nadee et al.'s model, as described in detail in 4.2.1, defines nine cross-over / conflict points TT, TF, TI, FT, FF, FI, IT, IF, II. The letter on the left represents the new system aspect, the letter on the right represents the old system aspect. Informal (I) represents the system intention, e.g., the strategy that the system uses. Formal (F) represents the formalised plan used in the system, which have been developed in the system to achieve the informal (e.g., the rules and processes). Technical (T) represents the tools used and the application of the formal (e.g., the technology solutions chosen, or the business language used). If a technical issue (e.g., the interface language) in the new system conflicts with some technical in the old system (e.g., the language of staff) then is a TT conflict occurs.

In the seminar I captured an adapted version of the Winai Nadee's eight statements, as described in detail in 4.2.1, using a 5-point likert scale. Each statement was designed to capture the attitude towards change of a specific aspect of change, i.e., in the new or old system. Tx question represents a positive intention to change the new technical structure to fit with the existing system. Fx represents a positive intention to change the new processes and formal rule to fit with the existing system. Ix represents a positive intention to change the new system purpose / functionality scope to fit with the existing system. xT represents a positive intention to change the old technical structure to align with the new system. xF represents a positive intention to change in the old t processes and formal rule to align with the new system. xI represents a positive intention to change the old system purpose / functionality scope to align with the new system. The nine interaction points, as defined by Winai Nadee, were calculated by combining the two question scores linked to that conflict state.

It was noted, in section 4.3.1, that use of a real-world seminar sessions limited the collection of data, however if data analysis shows i) consideration between T, F, and I layers within systems, and ii) consideration between TT, FF, and potentially II between systems then it is clear that students have understood the key issues being considered in this model.

Cleaned data from 368 respondents (as stated in section 4.3.2.) was used to analyse the dual aspect model. Interestingly, the theoretical nature of the dual aspect model poses a need to validate the conceptualise relations within the model. Hair et al. 2010 recommends the statistical validation of a theorised model with factor analysis. Additionally, I was able to reach a conclusion whether MM258 students understand the model constructs.

Factor Analysis

Chatfield and Collins (1992) describe factor analysis as a data reduction technique that identifies correlations between data variables and question items for each of the individual variables. Question items are accordingly grouped based on the strength of correlations amongst items. Strongly correlated items are then assigned as a single factor, which represents a factor concept. Factor analysis is normally performed using two steps - exploration and then confirmation of the factors. Exploratory Factor Analysis (EFA) highlights possible factors that best represent the relationships within the data (Hair et al., 2010). Confirmatory Factor Analysis (CFA), applied as a second step if data reliability is identified, helps the confirmation of factors represented in the previous step; thus demonstrating whether or not the extracted factors are in accordance with the theoretical model or not.

Exploratory Factor Analysis (EFA)

EFA helped to screen out the problematic survey items. The most common measure of the EFA is the Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy with Varimax rotation. The varimax method for the extraction was selected; and is the most commonly used variance maximising procedure due to its has high level of generalisability and replicability power when compared to the oblique rotational method. KMO is a measure of sampling adequacy and shows the adequacy of sample. A KMO value above 0.5 shows that the data is acceptable.

Three models EFA models were considered to allow specific student consideration i) between T, F, and I layers within systems (model 1), and ii) the relationship (TT, FF, and potentially II) between systems (models 2 and 3); since it was suggested by the research that satisfaction of this condition was demonstrate to an acceptable level that students have understood the key issues being considered in this model.

System Conflict - Model 1

In model one we are considering student consideration of relationship between T, F, I layers within systems (see 4.20). This, at the technical level, shows that students, comparing the conflict of technologies (in the TT state) consider (within the system) what impact this a change in technology norms would have on linked formal and technical norms. To model this we have to remove II, IF, FI, and FF state data, as this data is not required to test this model condition.

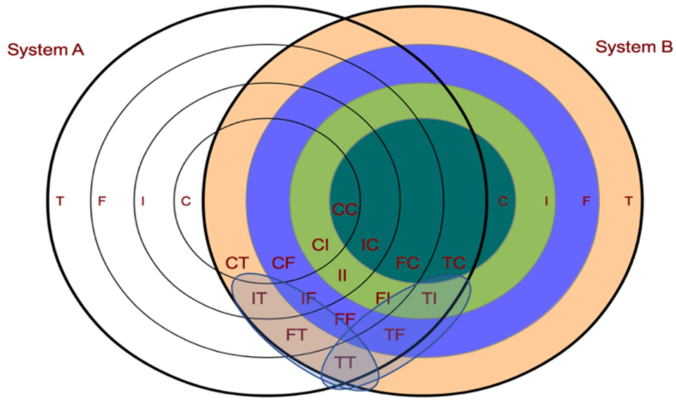


Figure 4.20. Dual-aspect model – consideration of T, F, I layers within systems.

IT	**FT**	**TT**	**TF**	**TI**	(Items included)
IF	**FF**	**FI**	**II**		(Items Removed)

Unrequired conflict states were removed, and data from the study was analysed. The resultant KMO for model 1 was 0.718, which provides positive evidence concerning the adequacy of the sample (see table 4.9). For Barlett's test sig < 0.05 is required, in our case it was 0.01. Both of the tests show that that the chosen items for each variable correlate.

Table 4.9. KMO and Bartlett's Test for Model 1 - consideration of T, F, I layers within systems.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.718
Bartlett's Test of Sphericity	Approx. Chi-Square	685.585
	df	10
	Sig.	<.001

The communality of data relates to the amount of variance in each variable that is accounted for. Hence the communality is the sum of the squared component loadings up to the number of components you extract, and its value range between from 0 and 1; with higher values exhibiting an explanation covering more variance (with values between above 0.4 demonstrating acceptable cut-offs, yet values above 0.7 showing ideal communalities). Table 4.10 shows that, for model 1, all conflict points, have an acceptable level of communality.

Table 4.10. Communalities for Model 1.

Communalities

	Initial	Extraction
TI	1.000	.791
TF	1.000	.719
TT	1.000	.865
FT	1.000	.778
IT	1.000	.775

Extraction Method: Principal Component Analysis.

Principle Component Analysis (table 4.11) shows reliable separation of two components, that support student consideration of the relationship between T, F, I layers within systems. Accordingly, we can assume that student do appreciate that change to norm layer would require alignment within the other layers within the same system.

Table 4.11. Principle Component Analysis for Model 1.

	Component	
	1	2
IT	.876	
FT	.870	
TT	.717	.592
TI		.887
TF		.817

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

System Conflict - Model 2

In model two we are considering student awareness of the relationship (TT) between systems (see figure 4.21). This, at the technical level, shows that students, are able to look between the two systems, and consider back and forth (FT – TT – TF) how technical change impact changes across both systems. To model this we have to removed data for conflict states II, IF, IT, FI, FF, and TI, as this data is not required to test this condition model.

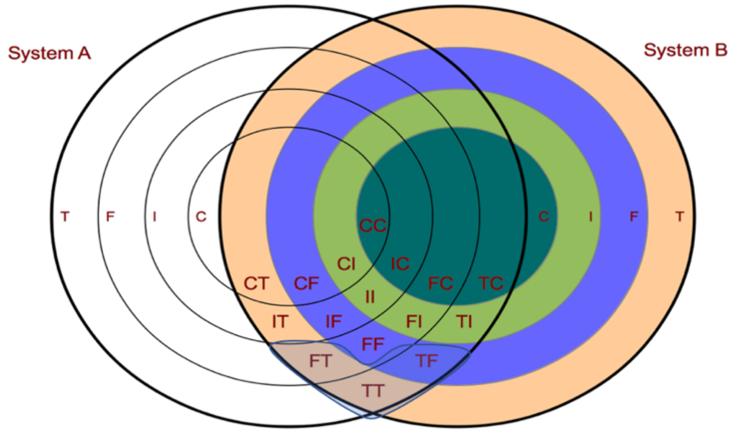


Figure 4.21. Dual-aspect model – considering student awareness of the relationship (TT) between systems.

TT	**FT**	**TF**				(Items included)
TI	**FF**	**IF**	**FI**	**II**	**IT**	(Items Removed)

Unrequired conflict states were removed, and data from the study was analysed. The resultant KMO for model 2 was 0.549, which provides positive evidence concerning the adequacy of the sample (see table 4.12). For Barlett's test sig < 0.05 is required, in our case it was 0.01. Accordingly, both of the tests show that that the chosen items for each variable correlate. Table 4.13 shows that, for model 2, all conflict points, have an acceptable level of communality.

Table 4.12. KMO and Bartlett's Test for Model 2 - considering student awareness of the relationship (TT) between systems.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.549
Bartlett's Test of Sphericity	Approx. Chi-Square	331.150
	df	3
	Sig.	<.001

Table 4.13. Communalities for Model 2.

Communalities

	Initial	Extraction
TT	1.000	.856
FT	1.000	.644
TF	1.000	.555

Extraction Method: Principal Component Analysis.

Moreover, results of the exploratory factor analysis for model 2, i.e., with state FT, TT, and TF, shows that only one component was extracted - covering and including the three conflict states as defined in the model (see figure 4.21). Since reliability of the model is good, we can confidently state that students do appear to have an awareness of technical alignment between two models.

System Conflict - Model 3

In model three we are considering student awareness of the relationship (FF) between systems (see figure 4.22). This, at the technical level, shows that students, are able to look between the two systems, and consider back and forth (FT – TT – TF) how technical change impact changes across both systems. To model this we have to removed data for conflict states II, IF, IT, FI, FF, and TI, as this data is not required to test this condition model.

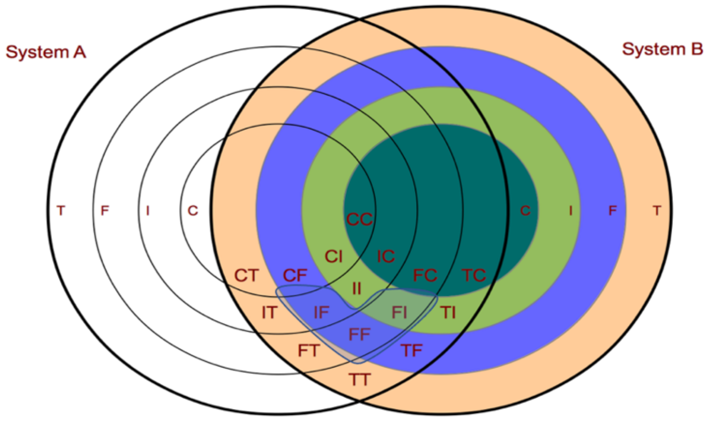


Figure 4.22. Dual-aspect model – considering student awareness of the relationship (FF) between systems.

FF	**IF**	**FI**				(Items included)
TI	**TF**	**TT**	**FT**	**II**	**IT**	(Items Removed)

Unrequired conflict states were removed, and data from the study was analysed. The resultant KMO for model 3 was only 0.461, which suggests that the evidence concerning the adequacy of the sample is insufficient (see table 4.14). For Barlett's test sig < 0.05 is required, in our case it was 0.01. Table 4.15 shows that, for model 3, all conflict points, have an acceptable level of communality.

Table 4.14. KMO and Bartlett's Test for Model 3 - considering student awareness of the relationship (FF) between systems.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.461
Bartlett's Test of Sphericity	Approx. Chi-Square	273.294
	df	3
	Sig.	<.001

Table 4.15. Communalities for Model 3.

Communalities

	Initial	Extraction
FF	1.000	.857
IF	1.000	.534
FI	1.000	.495

Extraction Method: Principal Component Analysis.

Principle Component Analysis (table 4.15) shows that, for model 3, although FF and IF have an acceptable level of communality, there seems to be some confusion in student understanding relating to changes in the processes of the new system to order to align to the original system intention.

Results of the exploratory factor analysis for model 3, i.e., with state IF, FF, and FI, shows that only one component was extracted - covering and including the three conflict states as defined in the model (see figure 4.22). It is positive that a single component was load, however since reliability of the model is not high, due to the low KMO score, we cannot confidently state that students have an awareness of the relationship needed to support formal alignment between systems.

Conclusion

The result from exploratory factor analysis suggests that students are able to understand norm conflict within systems, and technical alignment of systems. Although the EFA for formal alignment loaded as expected, i.e., as in figure 4.20, the KMO for data collected within seminars was sadly too low. Since students appear able to appreciate basic norm-based models, the dual aspect model could (if required) be used as the Kernel model within the design science research process, i.e., in order to answer research question 2.

4.4.2. UTAUT2

The UTAUT2 is a model that consists of seven factors (i.e., PE - performance expectancy, EE - effort expectancy, SI -social influence, FC -facilitating condition, HM - hedonic motivation, PV - price value, and HB - Habit). Since the seminar aims to allow students to critically consider Bandon's (an organisations) possible acceptance of an enterprise system, the original survey items, described in Venkatesh et al. (2012), could not be used. An alternative list of questions was developed with the primary focus of supporting student discussion, reflection, and consideration of acceptance factors. For full details of the questions, please see B4. Only participants with a full set of data were considered in data analysis – i.e., 384 (231 Females and 153 Males).

Exploratory Factor Analysis (EFA)

Questions that did not load effectively were removed, resulting in the removal of question PE8, HE3, HE4, SI1, SI2, FC1, HM1, PV3, PV4, PV5, HB1, HB2, and HB3. Once non-loading data was removed, the data was analysed. The resultant KMO was 0.760, which provides positive evidence concerning the adequacy of the sample (see table 4.16). A Barlett's test result was <0.01, suggesting that both chosen items for each variable correlate.

Table 4.16. KMO and Bartlett's Test for UTAUT2 question.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.760
Bartlett's Test of Sphericity	Approx. Chi-Square	5271.565
	df	1431
	Sig.	.000

Analysis shows that, for the UTAUT2 model, all questions had an acceptable level of communality, i.e., greater than 0.4, yet communality was not ideal (see table 4.17). Results suggest that students mostly understanding the questions, yet some improvement of questions would have been ideal. Principle component analysis (see table 4.18) highlighted the existence of 17 distinct groups, which initially implied a slightly confused view of the UTAUT2 model as the UTAUT2 model only has 7 factors. Interestingly factors such as Hedonic Motivation (component 1) - enjoyment, Effort Expectancy (component 2) - effort, and Performance Expectancy (component 3) - benefits, appear to load as a single combined component. This suggests that students are able to distinguish the business value equation, i.e., value = benefits / sacrifice, and are also able to distinguish some enjoyment as an intention driver.

Table 4.17. Communalities for UTAUT2 model.

Communalities

	Initial	Extraction
PE1	1.000	.595
PE2	1.000	.562
PE3	1.000	.572
PE4	1.000	.578
PE5	1.000	.534
PE6	1.000	.581
PE7	1.000	.598
PE8	1.000	.602
EE1	1.000	.578
EE2	1.000	.549
EE3	1.000	.645
EE4	1.000	.686
EE5	1.000	.551
EE6	1.000	.575
EE7	1.000	.717
EE8	1.000	.617
EE9	1.000	.648
FC1	1.000	.632
FC2	1.000	.727
FC3	1.000	.704
FC4	1.000	.729
FC5	1.000	.685
FC6	1.000	.562
FC7	1.000	.705
SI1	1.000	.649
SI2	1.000	.689
SI3	1.000	.723
SI4	1.000	.713
SI5	1.000	.672
SI6	1.000	.694
SI7	1.000	.622
SI8	1.000	.620
SI9	1.000	.593
HM1	1.000	.576
HM2	1.000	.612
HM3	1.000	.658
HM4	1.000	.584
HM5	1.000	.687
HM6	1.000	.666
HM7	1.000	.537
PV1	1.000	.577
PV2	1.000	.699
PV3	1.000	.618
PV4	1.000	.564
PV5	1.000	.532
PV6	1.000	.649
PV7	1.000	.635
HB2_Rev	1.000	.613
HB3_Rev	1.000	.672
HB1	1.000	.531
HB4	1.000	.711
HB5	1.000	.756
HB6	1.000	.718
HB7	1.000	.713

Extraction Method: Principal Component Analysis.

Table 4.18. Principal Component Analysis for UTAUT2 question data.

Rotated Component Matrix[a]

	Component																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
HM3	.765																
HM5	.762																
HM4	.738																
HM6	.726																
HM2	.675																
HM7	.559																
EE8		.717															
EE7		.709															
EE2		.613															
EE1		.601															
EE9		.585															
PE5			.656														
PE2			.632														
PE4			.566														
PE3			.546														
PE6			.540														
PE1			.522														
PE7			.427														
FC7				.804													
FC4				.776													
FC5				.773													
HB6					.809												
HB7					.751												
SI4						.798											
SI3						.770											
EE5						.439											
SI1																	
FC2							.809										
FC3							.796										
FC6							.588										
HB5								.712									
HB4								.672									
HB3								-.478									
PV6									.581								
PV7									.559								
HM1	.435								.473								
HB1									-.421								
PV5																	
EE4										.759							
EE3										.736							
SI7											.731						
SI8											.669						
SI6												.785					
SI5												.784					
PV1													.680				
PV2													.661				
SI9														.716			
FC1															.713		
PV3													-.423		.431		
EE6																.676	
SI2																	.753

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 24 iterations.

Other factors, however, such as Habit (components 5 and 8), Facilitating Condition (components 4 and 7) considering required resources, Social Influence (components 6, 11, and 12), and Price Value (components 9 and 12) appear split between multiple components. The split is most likely because of students considering multiple factors; for example, social influences are separate by stakeholder with component 6 representing internal social influence, component 11 representing external social influences, and 12 representing supply chain social influences.

To understand further this split I i) grouped loading questions, i.e., to try and make sense any connections, and ii) informally spoke to students in the 2019 - 20 cohort about the results to try and understand why multiple UTAUT2 had split into multiple components.

The following shows PCA components consisting of more than one question that grouped together, as suggested by table 4.17. I then proposed a themed title that linked the questions.

PE
PE1. The proposed change will not improve Bandon's technology capability
PE 2. The proposed change will not improve Bandon's business processes
PE 3. The proposed change will not improve Bandon's business model
PE 4. The change will not increase Bandon's profits
PE 5. The change will not increase Bandon's turnover
PE 6. The change will not enable Bandon to accomplish tasks more quickly
PE 7. The change will not benefit Bandon's suppliers
REMOVED PE8

EE1 (Change)
EE1. Bandon will not easily implement the change
EE2. Bandon's technology will not be easy to change
REMOVED EE3-EE4 makes EE2 (focus), EE5 part of Social (Internal)
EE7. The change will cost Bandon lots of money
EE8. The change will take a long time.
EE9. The change will require considerable ongoing maintenance.

EE2 (Focus)
EE3. Bandon's processes will not need to change.
EE4. Bandon's business model will not need to change.

SI1 (Internal)
REMOVED SI1 and SI2
EE5 The change will require considerable internal staff training.
SI3 It is important that Bandon staff approve changes to processes.
SI4 It is important that Bandon customers agree with changes.

SI2 (Supply chain)
SI5 It is important that Bandon customers agree with changes.
SI6 It is important that Bandon's suppliers agree with changes.

SI3 (External)
SI7 Competitors are making similar changes and it is important to keep up.
SI8 Technology innovation is pushing Bandon towards making this change.

FC1 (Human)
REMOVED FC1
FC2 Bandon's current technology do not support the proposed change.
FC3 Bandon's current processes do not support the proposed change.
FC6 Bandon's current business model does not support the proposed change.

FC2 (Physical Resources)
FC4 Bandon's staff do not have the skills needed to implement the ERP/CRM.
FC5 Bandon's staff do not have the skill to maintain the ERP/CRM.
FC7 Bandon's staff do not have the skills needed to use the ERP/CRM.

Hedonic Motivation (HM)
REMOVED HM1
HM2 Bandon staff will not enjoy engaging in the change.
HM3 Bandon staff will not enjoy working with the ERP/CRM project team.
HM4 Bandon staff will not enjoy the required management / process changes change.
HM5 Bandon staff will not enjoy using the new ERP/CRM technology.
HM6 Bandon staff will not enjoy using the new ERP/CRM processes.
HM7 Bandon customers will not enjoy engaging with the new solution.

PV1 (Cost)
PV1 Bandon management do not understand the Total Cost of ERP/CRM Ownership
PV2 Management do not believe ERP/CRM software costs are reasonably priced.
REMOVED PV3-5

PV2 (Supply Chain)
PV6 The ERP/CRM will not increase customer value of Bandon.
PV7 The ERP/CRM will not increase supplier value of Bandon.

HB1 (Internal)
REMOVE HB1 to HB3
HB4 Staff are unlikely to use the technology.
HB5 Staff are unlikely to use the new processes.

HB2 (Supply Chain)
HB6 Customers are unlikely to use the ERP/CRM.
HB7 Suppliers are unlikely to use the ERP/CRM.

Grouped loaded questions make sense, and mostly appear to represent (with some slight abnormalities) subcategories of the main UTAUT2 model factors. Students from the 19-20 cohort agreed that they understood the UTAUT2 model (despite being taught remotely due to the covid-19 pandemic) but results appear to also show consideration of stakeholders and/or key performance indicators.

Confirmatory Factor Analysis (CFA)

Results suggest that students do appreciate the UTAUT2 model, yet that the design and use of question items is key to the shape and reliability of the model being interpreted by the students; suggesting that the perceived outcome is not conceptually fluid, but rigidly determined using specific questions. To consider this point in more detail I conducted Structured Equation Modelling on the collected UTAUT2 seminar data (see figure 4.23).

Validity checks (see table 4.19) highlighted the following concerns for the UTAUT2 seminar SEM:

- Discriminant Validity: the square root of the AVE for PerExp is less than one the absolute value of the correlations with another factor.
- Reliability: the CR for PV_Supplychain is less than 0.70.
- Convergent Validity: the AVE for PerExp is less than 0.50.
- Discriminant Validity: the AVE for PerExp is less than the MSV.
- Convergent Validity: the AVE for EffExp is less than 0.50.
- Reliability: the CR for EE_Focus is less than 0.70.
- Convergent Validity: the AVE for EE_Focus is less than 0.50.
- Reliability: the CR for SI_Internal is less than 0.70.
- Convergent Validity: the AVE for SI_Internal is less than 0.50.
- Reliability: the CR for SI_External is less than 0.70.
- Convergent Validity: the AVE for SI_External is less than 0.50.
- Reliability: the CR for SI_SupplyChain is less than 0.70.
- Convergent Validity: the AVE for SI_SupplyChain is less than 0.50.
- Convergent Validity: the AVE for FC_Human is less than 0.50.
- Convergent Validity: the AVE for HedMot is less than 0.50.
- Reliability: the CR for PV_Cost is less than 0.70.
- Convergent Validity: the AVE for PV_Cost is less than 0.50.

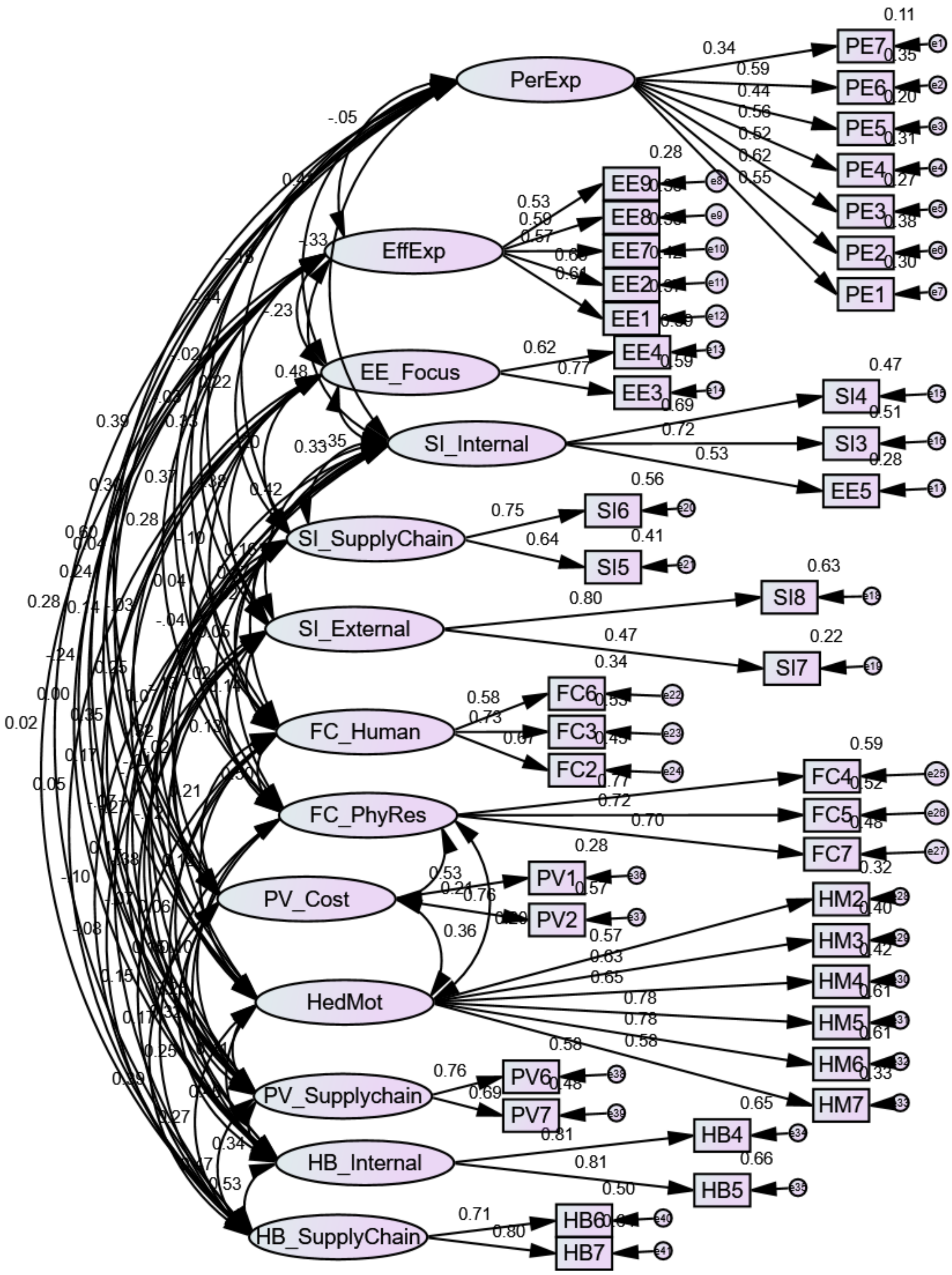


Figure 4.23. Structure Equation Model of UTAUT2 seminar data.

	CR	AVE	MSV	ASV	PV_ S..C. .	Per Exp	EffExp	EE_ Focus	SI_ I..	SI_ E..	SI_ S.. Ch..	FC_ H..	FC_ P..E..	Hed..	HB _ I..	PV_ Cost	HB_ S..C..
PV_Supplychain	0.69	0.528	0.356	0.123	0.73												
PerExp	0.72	0.275	0.356	0.103	0.6	0.52											
EffExp	0.73	0.349	0.231	0.062	-0.24	-0.05	0.591										
EE_Focus	0.65	0.488	0.168	0.064	0.35	0.41	-0.232	0.699									
SI_Internal	0.68	0.423	0.231	0.078	-0.32	-0.33	0.481	-0.354	0.650								
SI_External	0.58	0.428	0.196	0.072	-0.38	-0.44	0.331	-0.385	0.416	0.654							
SI_SupplyChain	0.66	0.489	0.108	0.030	-0.27	-0.15	0.215	-0.202	0.329	0.170	0.700						
FC_Human	0.70	0.440	0.249	0.046	0.06	-0.02	0.373	-0.100	0.162	0.139	0.048	0.664					
FC_PhyRes	0.77	0.534	0.249	0.045	0.1	-0.03	0.284	0.044	0.022	0.134	-0.018	0.499	0.731				
HedMot	0.83	0.449	0.210	0.070	0.41	0.30	0.140	0.246	-0.132	-0.119	-0.009	0.120	0.203	0.670			
HB_Internal	0.79	0.656	0.284	0.075	0.34	0.24	0.000	0.170	-0.166	-0.068	0.137	0.146	0.264	0.458	0.81		
PV_Cost	0.59	0.425	0.154	0.057	0.32	0.39	0.039	-0.026	-0.044	-0.018	0.070	0.206	0.210	0.356	0.25	0.652	
HB_SupplyChain	0.73	0.571	0.284	0.074	0.47	0.29	0.019	0.046	-0.069	-0.077	-0.101	0.146	0.168	0.268	0.53	0.392	0.755

Table 4.19. Validity testing for UTAUT2 Seminar Data CFA components.

The CMIN score, which are used to compare observed variable and expected results, indicates if the sample data and the hypothetical model are an acceptable fit in the analysis. If the CMIN / DF value is less than or equal to 3 it indicates an acceptable fit (Kline, 2005). In our model CMIN/DF is 1.483 (see table 4.20), so the model implies an acceptable fit to data, however $p<0.001$ yet this is most likely due to the large sample size of 384; and so it is unlikely that the p value will ever be greater 0.05.

Table 4.20. Interpreting CMIN.

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	160	1039.370	701	.000	1.483
Saturated model	861	.000	0		
Independence model	41	4108.736	820	.000	5.011

GFI stands for goodness of fit index and calculate the minimum discrepancy function need to achieve perfect fit (Jöreskog & Sörbom, 1984; Tanaka & Huba, 1985). GFI value should be ideally 1, i.e., the perfect fit, however values greater than 0.95 indicate an excellent fit (Kline, 2005), and values 0.9 to 0.95 indicate a reasonable fit (Hu and Bentler, 1998). Accordingly, out data – with GFI of 0.866 - suggests a tolerable but not great fit (see table 4.21).

Table 4.21. Interpreting GFI.

Model	RMR	GFI	AGFI	PGFI
Default model	.045	.866	.836	.705
Saturated model	.000	1.000		
Independence model	.146	.485	.459	.462

Finally, I considered the RMSEA model fit (table 4.22), which represents the Root Mean Square Error of Approximation – i.e., the different between what was observed and what was predicted. The key value of interest here is the RMSEA in the default model, which should be less or equal to 0.05 to indicate a good model fit (MacCallum et al., 1996). Accordingly, RMSEA implies a good model fit.

Table 4.22. Interpreting RMSEA.

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.039	.034	.044	1.000
Independence model	.112	.109	.116	.000

Although model fitness results vary, it suggests an acceptable level model fitness, which was in line with the expectation. The used questions were designed to support teaching of the seminar topics and was not designed to support subsequent structured equation modelling. Although fitness is not perfect, an acceptable model fitness suggests that figure 4.20 is a fair representation of what students understand from the technology acceptance seminar.

Conclusion

Although the UTAUT2 model facilitates students in the consideration of factors impacting technology acceptance, I found it to be very rigid and contextually bound – e.g., use with individuals not groups, and successful load only if you use a specific set of pre-defined questions that limit flexibility in the consideration of ‘additional’ factors. From data analysis, and subsequent informal discussion with students, the appeared to understand the model, however the UTAUT2 seems unable to effectively consider external factors and sub distinctions of factors.

I did not restrict questions to those defined by Venkatesh et al., i.e., to ensure consideration of issues such as business process, business model, profits, stakeholder interaction, etc. The questions used in this research allowed focus on additional factors, but due to the model rigidity there feels to be a tension between investigation of the domain and validity of the model. This tension raises a significant question as to viability to use of fixed context models, such as UTAUT2; since the rigidity of the model, and therefore application of use, prevents adaptation for consideration of additional factors.

Students certainly understand such fixed models, yet such models are contextually limited, as the model is refined and simplified, i.e., via reworking of questions and removal of data to a point where model fit reliability is possible.

By simplifying reality, I was able to develop accurate mathematical representations a small aspect of the world, however in reality any change threatens the reliability of the model. Use of such fixed context model assumes a fixed and consistent world model, which aligns to Robert Kegan's Level 3 thinking (i.e., a socialised mind), and therefore this is not ideal for holistic modelling. Unlike the dual-aspect model, fixed models, such as UTAUT2 are not able to support generic discussion outside the pre-defined context without the model reliability and fit being significantly threatened.

Analysis in this chapter suggests that use of a fixed structure model, i.e., as the Kernel theory for the design science research process, is impractical. Although those students appreciate these models, the models themselves are not flexible enough to represent the complexity that occurs at a systems level (Kegan's level 4 – self-directed thinking), which requires the ability for different systems to have different perspectives and/or different structures.

4.4.3 Pankratz and Basten

To determine if students had understood the model, 26 questions were developed (see appendix B5). One question was developed for each failure factor being considered. Factors we selected to ensure a coverage of failure dimensions (i.e., with between 5 and 9 factors mapping to Pankratz and Basten failure dimensions) – see table 4.7 - and a fair allocation across failure categories. For full details of seminar slides, and question items used in seminar 3, see appendix B5. Only participants with a full set of data were considered in data analysis – i.e., 384 (231 Females and 153 Males).

Due to the complexity of the model, and the limited number of questions, I expected that results would not load perfectly. As such, if fair loading exists either across specific categories or dimensions, i.e., all questions for specific categories or dimensions loading together, then this will demonstrate a basic understanding of students.

EFA

No question items were removed from the analysis. The resultant KMO was only 0.920, which suggests that the evidence concerning the adequacy of the sample is insufficient. For Barlett's test sig < 0.05 is required, in our case it was less than 0.01 (see table 4.23).

Table 4.23. KMO and Bartlett's Test for Pankratz and Basten seminar.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.920
Bartlett's Test of Sphericity	Approx. Chi-Square	2978.320
	df	325
	Sig.	.000

Table 4.24 shows that, for the Pankratz and Basten model, many of the questions do not possess an acceptable level of communality. Since the communality is low, we can assume that several question items were confusing – and the variables have little in common with the other variables - implying that data is not likely to load reliably. Despite the low communality, I decided to continue to PCA, i.e., to try to understand student perception (see table 4.25).

Table 4.24. Communalities for Pankratz and Basten Model.

Communalities

	Initial	Extraction
q1	1.000	.591
q2	1.000	.598
q3	1.000	.533
q4	1.000	.661
q5	1.000	.478
q6	1.000	.481
q7	1.000	.439
q8	1.000	.366
q9	1.000	.419
q10	1.000	.439
q11	1.000	.310
q12	1.000	.464
q13	1.000	.392
q14	1.000	.400
q15	1.000	.469
q16	1.000	.341
q17	1.000	.357
q18	1.000	.478
q19	1.000	.355
q20	1.000	.637
q21	1.000	.594
q22	1.000	.599
q23	1.000	.564
q24	1.000	.526
q25	1.000	.457
q26	1.000	.340

Extraction Method: Principal Component Analysis.

Interestingly, despite being the most complex model, only four components were identified from the principal component analysis (see table 4.25) with the last component realistically only loading to one question – implying removal of this component from consideration. It appears that the complexity of different categories, and/or different dimensions (representing specific KPI) was lost to students.

Table 4.25. Principal Component Analysis for failure factor question data.

Rotated Component Matrix[a]

	Component 1	2	3	4
q1	.743			
q2	.734			
q3	.706			
q4				.779
q5	.490			
q6	.616			
q7	.566			
q8	.537			
q9	.543			
q10		.531		
q11				
q12			.577	
q13			.549	
q14			.481	
q15			.641	
q16				
q17			.507	
q18			.550	
q19				
q20		.771		
q21		.729		
q22		.721		
q23		.721		
q24		.540		
q25	.483			
q26			.500	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The complexity of the model, with 54 different questions loading into 10 categories, and 8 dimensions loading across multiple factors is not intuitive. Interesting students appear to define consistently three clear and distinct implementation categories – i) Issues relating to planning – condition 1 (i.e., incorporating condition, directed decision, insufficient consideration of customer, project planning factors), ii) during implementation – condition 3 (i.e., incorporating. project management and change management issues factors), and iii) other project factors – condition 2 (i.e., incorporating Project management issues, customer contract issues, technology, and unexpected events factors) (see table 4.25). This simplified model of implementation is not something that was explicitly taught to students in this seminar, however, this interpretation does link to module content relating to the development life cycle; where i) planning, analysis, and design, is followed by ii) implementation, testing, and maintenance, but impacted by iii) business, management, and technology dimensions of information systems.

When 19-20 cohort students were informally asked about the Pankratz and Basten model, they stated that the causes of specific failures were hard to appreciate as the cause of failure seemed different in each example, and/or a simple set of cause-and-effect rules (unlike the norms in the dual-aspect model) could not be identified or followed. Moreover, students found it hard to contextualise how specific categories had an impact, in part due to student lack of experience, on business outcome.

It is possible that, with additional time and sufficient use cases, the different categories and/or dimensions described in the Pankratz and Basten model could be expounded to students, however effective coverage would be difficult in the time allowed within UG teaching module.

Conclusion

Although the Pankratz and Basten model describes exhaustively the complexity of systems failure, students do not appear to appreciate the granularity of specific categories, instead identifying three key phases, i.e., i) planning, 2) implementing, and iii) other project factors. This simplified model aligns well with the software development life cycle and suggests that students are better able to see appreciate information systems implementation by considering explicit phases and steps, rather than interaction.

Students do not appear to appreciate this level of complexity when described yet do appreciate specific points when each is explained in context. Although this suggests that students could understand the model in time, the complexity of decomposing the model and reshaping the model for education suggests that this is not effective as a kernel module for use in the design science research process.

4.5. Kernel Model Selection

In section 4.5 I analysed data concerning user perception of three models, i.e., the Dual Aspect system conflict Model (Nadee et al., 2017), the UTAUT2 technology acceptance Model

(Venkatesh et al., 2012), and the Pankratz and Basten failure model (Pankratz and Basten, 2013). The three models, although distinctly different, are used in the MM258 module to support discussion of three key concepts (systems conflict, technology acceptance, and systems failure) within the domain of information systems in business. When students are presented with the dual aspect model, in section 4.4.1, results showed that most students can comprehend simple norm-based conflict models, and are able to appreciate within system norm conflict, and across system technical alignment, the primary touch point of systems. As such the dual-aspect model could be used as the kernel model – as it provides considerable scope for adaptation and development. When students are presented with the UTAUT2 model, in section 4.4.2, results showed that most students comprehend the model factors, however it seems that use of the original question items is mandatory to ensure model fit. I used an alternative set of questions, to support seminar teaching, however this impacted model loading. It appears that such models are developed to represent a fixed snapshot of one domain. Consideration of other domains, or other factors requires an alternative model, resulting in student creating a separate model for each instance, technology, or circumstance. Although this does result in the endless production of slightly different research papers, it does not support the flexibility needed to provide a holistic model. Accordingly, the UTAUT2 (or a similar fixed model) is not ideal as the Kernel theory for design science. When students are presented with the Pankratz and Basten model, in section 4.4.3, students fail to appreciate the complexities and granularity of the model, and instead replace the model with three key phases, i.e., i) planning, 2) implementing, and iii) other project factors. Students do not appear to appreciate this level of complexity when described as a whole, yet decomposition of the model would be impractical.

Students requires a holistic model that is simple in form (unlike the Pankratz and Basten model), but flexible in nature (unlike the UTAUT2 model). Accordingly, I believe that the Dual Aspect Model (See figure 4.24) is practically the best model for adaption in the design science process, and therefore defined the dual-aspect model as artefact 1. The model can easily represent any systems (i.e., people, organisations, and/or technology systems), and each system and/or subsystem can be represented by a separate dual-aspect model.

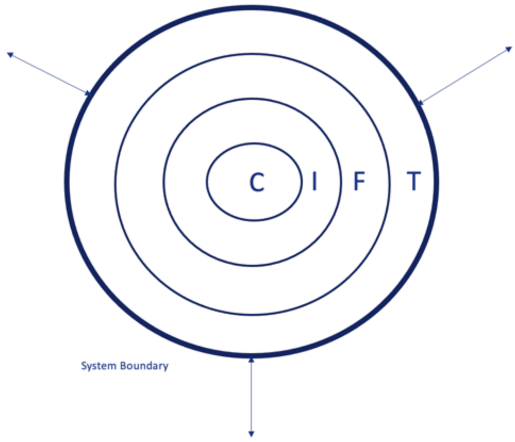


Figure 4.24. Artefact 1 - Dual Aspect Model (the Kernel Theory).

Although there are some shortfalls in the model, e.g., the dual-aspect model assumes concentric dependency, the dual-aspect model does not really describe the application of the conceptual layer (as conflict points ignore consideration of concept norms), and the dual-aspect model does not explain the flow of interaction between layers.

Within part three of this thesis I will adapt artefact 1, the kernel theory, to support effective use as a holistic model to support UG pre-experience teaching of information systems.

4.6. Conclusion

This chapter aim to have three outcomes. Firstly, the research hoped to introduce the reader to through information systems, i.e., the Dual Aspect system Model (Nadee et al., 2017), the UTAUT2 technology acceptance Model (Venkatesh et al., 2012), and Pankratz and Basten failure model (Pankratz and Basten, 2013). Secondly I aimed to capture empirical quantitative data from MM258 seminar sessions, and finally I aimed to analyse data to critically determine the kernel theory to be used as the basis for design science.

Although limitations were identified in the collection of data, due to data being captured within a real-world teaching environment, the research was able to critically consider student understanding of each of the three models and is able to propose the dual-aspect model (by Nadee et. al, 2017) as the kernel theory for use in design science research adaptation.

PART THREE

HOLIST MODEL DEVELOPMENT

Chapter 5
Artefacts 2 to 5

5.1 Introduction

In chapter 4 I assessed the understanding of students when presented with three information systems models. Results highlighted that: i) most students were able to comprehend a simple norm-based conflict models – see 4.4.1; ii) students found fixed context models, such as UTAUT2, to be restrictive, i.e., only allowing discussion within the scope of the validated question items– see 4.4.2; and iii) students were not able to understand complex abstract multi-dimensional matrix models, such as the Pankratz and Basten model – see 4.4.3. At the end of chapter 4 I concluded that, to facilitate the basic understanding of pre-experienced undergraduate students, the use of a simple norm-based conflict model was ideal as the kernel theory without the design science research development of a holistic information systems model – see figure 5.1.

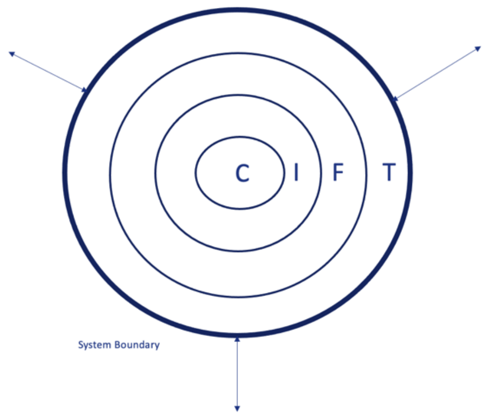


Figure 5.1 - Dual Aspect Model defined as the Kernel Theory.

In line with design science research (DSR) the following chapter iteratively develops the Kernel model, i.e., by resolving problems with the dual-aspect model and introducing complexity that supports information systems educators in introducing, discussing, and critically evaluating key information systems concepts and theories.

With each iteration we follow the key DSR steps, as proposed by Vaishnavi and Kuechler (2004), i.e., i) awareness of the problem, and ii and iii) suggestion and development, which were combined to improve the narrative flow. At the end of iteration, we then identify issues / problems to support circumscription, i.e., the identification of some restriction that continues to limit the as-is artefact. At the end of the chapter, i.e., after description of artefact 5, the research will undertake iv) an evaluation of the artefact 5 by critically discussing whether the revised model is able to facilitate the teaching covered by current information systems models. At the end of the iteration process, i.e., at the end of chapter 6, I will conduct a second iv) evaluation, and finally v) a conclusion is provided.

5.2. Artefact 2 – Flux Model - Re-considering Why, How, and What.

5.2.1. Awareness of the Problem.

The Dual Aspect model (Nadee et al., 2017) – see figure 5.1 - is composed of four concentric circles relating to different types of norms. Liu and Li (2014) stated that the standard norm definition should be written in the form:

Whenever <condition>
then <an agent>
is <deontic operator>
to do <action>

At the centre of the Dual Aspect model is the 'C' concept layer, which relates to the 'why' the system exists. The concept layer defines the fundamental purpose of the system and is used to critical guide the system goals. The next layer in the Dual Aspect model is the 'I' Informal layer, which relates to the unplanned intent of how the purpose will be achieved. For example, In the 1960s America expressed the intention to go to the moon, however at that point in time, when the intention was defined, no explicit plan had been created. The next layer in the Dual Aspect model is the 'F' formal layer, which relates to the plan that states what needs to be implemented to achieve the informal intent. The formal layer relates to norms that define the rules, regulations, and structures that need to be put in place to facilitate the practical implementation. When America decided to implement the moon landing, significant planning was required to ensure that the dream was realised in the form of a plan. A series of events and activities were then expounded to ensure that all required steps were developed to ensure completion of the goal Together 'I' and 'F' describes 'what' the system aims to achieve. The final layer in the Dual Aspect model, which interacts across the system boundary, i.e., with other systems, is the technical layer (see figure 5.1). There may be multiple techniques that could be used to implement the plan, however if the plan (described in the formal layer) is not effectively implemented then the outcome will not be achieved. The technical layer relates to all the norms concerning how something is achieved. By understanding the 'best' implementation, dependent on the focus KPI, the most optimal solution to implementation can be identified and applied. By bringing two dual aspect models together, representing the interaction of two systems, as highlighted in section 4.2.1., we can consider the interaction between different system norms.

Although the Dual aspect model makes considerable sense, the results of Nadee et al.'s (2017) Structured equation model (see figure 5.2), and subsequent critical consideration has highlighted several issues and problems that should ideally be resolved.

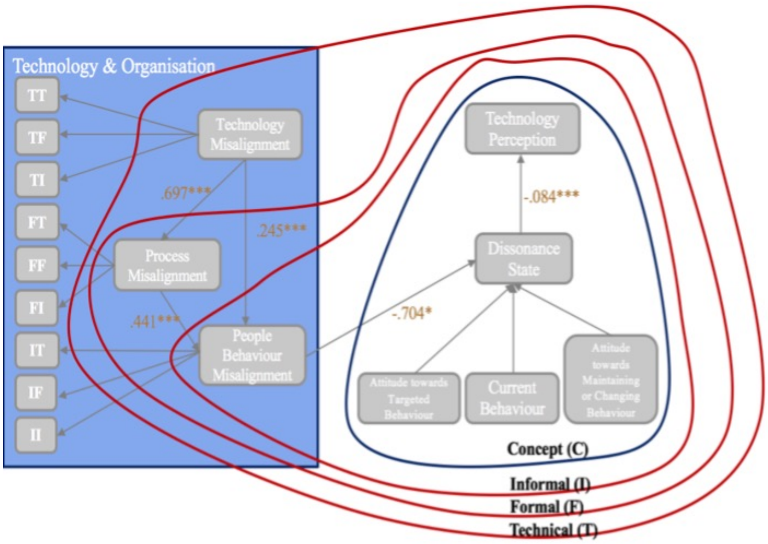


Figure 5.2 – Nadee et al.'s SEM Model – justifying the CIFT layer structure (adapted from Winai et al., 2017).

Issue that are not considered in the Nadee et al. (Artefact 1) include:

- Nadee et al.'s model, i.e. using concentric dependency circles, fails to support direct external influence of formal, informal, and/or conceptual norms; raising the problem of how goals are created.
- Nadee et al. model ignoring the direct connection that exists in their structure equation model – see figure 5.2 - between technical and informal layer.
- Nadee et al. model not describing the purpose or function of the conceptual layer.
- Nadee et al. model not explaining the flow and/or interaction between layers.
- Nadee et al. does not describe how external conflict is managed.

- Nadee et al. does not consider the resolution between different internal types of norms, i.e., formal, informal, and technical.
- Nadee et al. does not consider the resolution between multiple conflicting norms of the same type, e.g., conflicting rules.
- Nadee et al. does not discuss specifically the flow between norms.

In this artefact we propose a structural adaptation that will hopefully address these issues.

5.2.2. Suggestion / Development

A possible solution was presented by Kurt Lewin in his book "principles of topological psychology'. Kurt Lewin, the father of action research and a considerable pillar in the world of experimental learning (see 2.4.8), stated that the dependency of the degree of unity in a systematic structure depends significantly on the layout of component parts. Lewin proposed three possible alternatives (see figure 5.3). Within model A each component can only impact the component to the left or right suggesting a sequential processing of events (such as a production line). In B each numbered components are influenced by the previous (as is the case in the dual-aspect model, i.e. where technical norms are influenced by formal norms, which is influenced by informal norms, which is then influenced by conceptual norms). In models A and B each component is triggered in turn, and transference from layer 1 to 3 is impossible without interacting with and through layer 2. Within model C (see figure 5.3), however, Lewin suggested that each component directly connects with every other component and that connection between all components are only ever one path away. A similar layout was used in Nunamaker et al. (1991) to describe DSR (see figure 3.2).

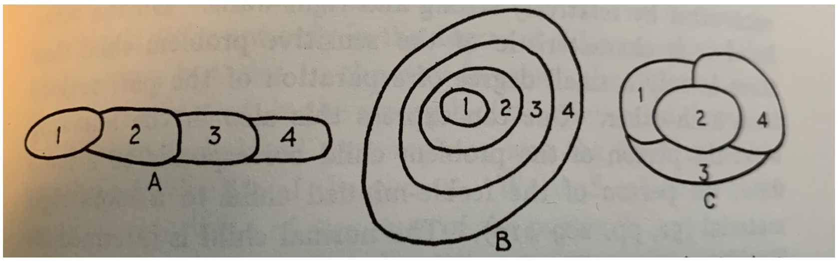


Figure 5.3 – Dependency relationship (taken from Lewin, 2013).

The proposed flux model (artefact 2 – see figure 5.4) replaces the model B topology (i.e., a traditional concentric layer dependency) with a model C topology. With a model C topology each set of norms (i.e., technical, formal, and informal) can interact bi-directionally, and directly, with all other types of norms; both with norms from other systems – via the system boundary – but also with other types of norms within the same system (see figure 5.4).

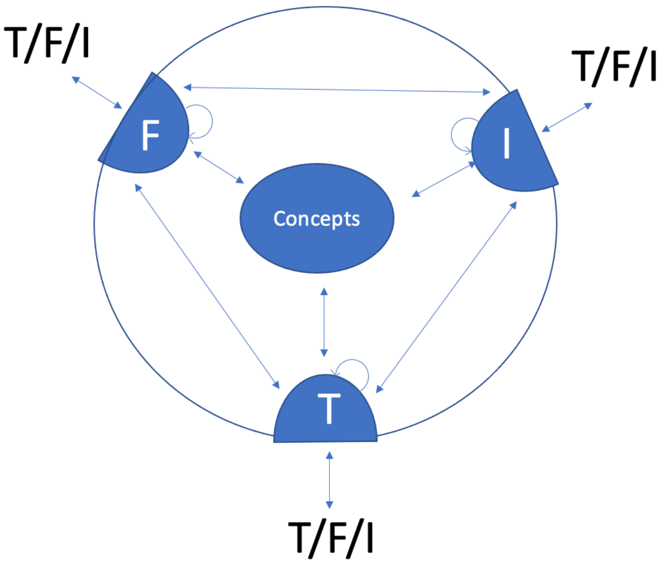


Figure 5.4. The basic 'Flux' model.

Due to the removal of concentric dependencies in the system, norms are now potentially influenced directly by technical, formal, and informal norms from outside the system, e.g., respectively an observed skill or method, a change in the law, or an externally driven inspiration to achieve something. I call the direct interaction between norms of different systems 'inter-conflict' - marked 1) in figure 5.5. Intra-norm conflict allows an interaction between different norm types within the same system – marked 2) in figure 5.5. As such formal norms (the 'planned what') can now be directly influenced by the world outside the system boundary (e.g., such a new mandated legislation); i.e., without having to pass through or be managed by a technical norm.

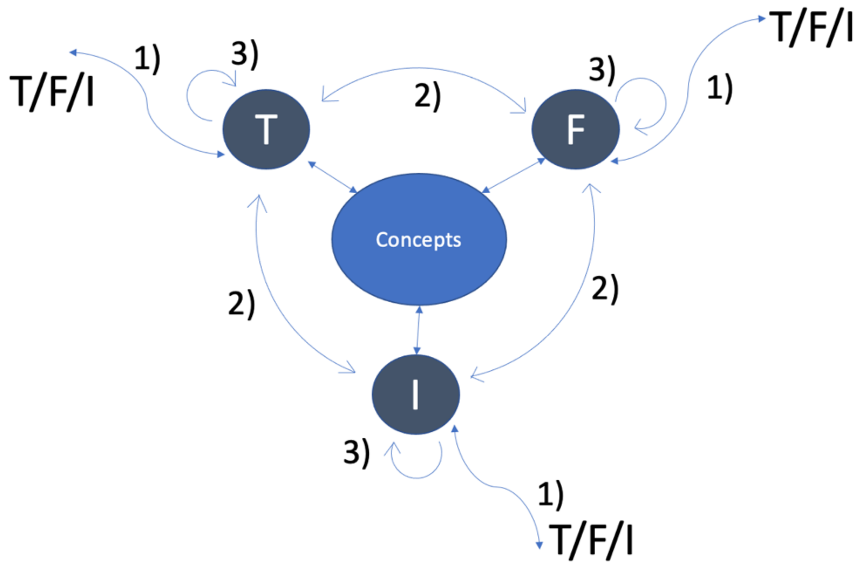


Figure 5.5 – Direct norm interaction demonstrating 1) Inter, 2) Intra, and 3) Inner.

As such formal rules might be imposed on the system, and internal technical norms must be aligned to ensure that the system output (the 'how' something is done) satisfies the formal norms of the society. The alignment of concept, informal, informal, and technical norms - within the same system – was termed intra-norm conflict. If 'how' something should be done (due to a new law) conflicts with 'what' is actually done, then dissonance should exist. If a formal rule change is mandated by an external source, then failure to make relevant internal changes to the formal and technical norms – i.e., to change 'how' something is planned and 'what' is achieved - to meet the new rules could result in a negative or penalised outcome. If numerous conflicting norms (of the same type) exist within the same system, for example the local rule conflicts with a new law, then an inner-norm formal conflict would exist. Inner conflict - marked 3 in figure 5.4 – exists when norms (or the same type) are in conflict in the same system. If internal norm conflict is not resolved, then the system will be unreliable and/or in constant conflict with itself.

The shift to a model C topology was a subtle yet significant change. Within the original dual aspect model all system outputs required use of technical norms. Within the flux model, however, it is possible for a system to interact also with formal and informal levels. As such interaction with other systems is no longer bound to resolved actions but might express a formal planned outcome (still to be completed), or even relate to an unplanned informal intention (still to be planned or completed).

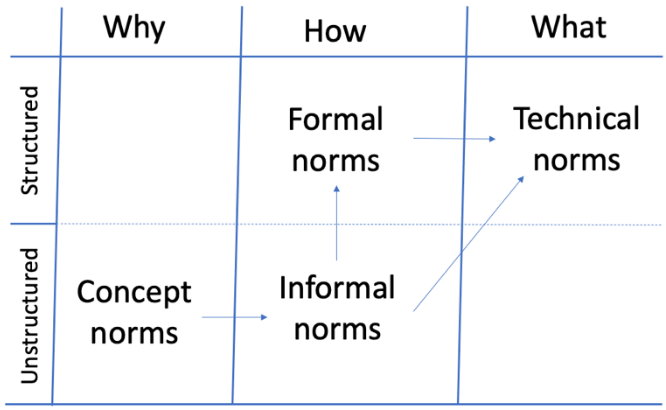


Figure 5.6. Nadee et al. (2017) SEM norm interaction.

Figure 5.6. represents the primary flow of interaction between norm types, expounded from the SEM data in Nadee et al. (see figure 5.2). The flow between concept layer and informal was possible in artefact 1, however artefact 2 supports i) direct inner-conflict interaction between informal and technical norms (not previously possible), and ii) allows direct comparison of all norms and concept norms (to support internal resolution of dissonance); managed by a central concept or belief. This idea aligns well with the layers of the golden circle - described by Simek (2009), see figure 4.4. Simek's model contained three concentric layers (i.e., WHY / HOW / WHAT), which are used to describe respectively the purpose / belief / intent of the system, however our artefact 2 is potentially much more powerful as it suggests that, in parallel, dissonance could exist between i) conflicting norms in the same system of the same type (inner), ii) conflicting norms of different types in the same system (intra), and iii) conflicting norms across different systems of any type (inter) – see figure 5.5.

I called this solution the 'flux model', i) because the flux model allows consideration of conflict, and a need for resolution and flux in inter norms (between systems), intra norms (between types of norms), and inner norms (between norms of the same type) – driven conceptually by a conceptual norm goal, and ii) because the flux model looks distinctly like the flux capacitor from back to the future (which made me smile).

5.2.3. Critical Evaluation

In section 5.2.1 we stated that the issues not considered in the Nadee et al. (Artefact 1) included:

- Nadee et al. model, not using concentric dependency circles, fails to support direct external influence of formal, informal, and/or conceptual norms; raising the problem of how goals are created.
- Nadee et al. model ignoring the direct connection that exists in their structure equation model – see figure 5.2 - between technical and informal layer.
- Nadee et al. model does not describe the purpose or function of the conceptual layer.
- Nadee et al. model does not explain the flow and/or interaction between layers.
- Nadee et al. does not describe how external conflict is managed.
- Nadee et al. does not consider the resolution between different internal types of norms, i.e., formal, informal, and technical.
- Nadee et al. does not consider the resolution between multiple conflicting norms of the same type, e.g., conflicting rules.
- Nadee et al. does not discuss specifically the flow between norms.

In artefact 2, entitled the basic flux model, I removed use of concentric dependant circles, thus supporting the direct interaction of all norms. This does not remove the problem of how goals are created yet does support the direct connection between concept (goal) norms – justifying the purpose of the concept layer - and other normal structures (i.e., informal, formal, and technical). Moreover, artefact 2 facilitates a direct connection between technical and informal norms, which better represents the structure equation model presented in Nadee et al. (2017). The direct connection of norms, whilst supporting the direct interaction of technical, formal, and informal norms with external norms, allows a dynamic interplay of three types of conflict (inter – between norms in different systems, intra – between different norm types in the same system, and inner – between different norms of the same type in the same system); allowing a dynamic flow and interaction between reasoning norms structures (not layers), but also considers identifies the need to consider resolution of dissonance.

Although creation of goals, and/or resolution of dissonance, is not solved in artefact 2, all other raise issues were effective sorted. Solving creation of goals will be considered in artefact 3. Resolving conflict will be done in two parts – i.e., in artefact 4 and 5.

5.3. Artefact 3 – Add system goals and Consideration of External Influences

Within artefact 2 we considered i) direct connection between the conceptual norm structure (not layer) and informal, formal, and technical norm structures, ii) direct interaction between informal, formal, and technical norm structures, and iii) direct interaction between norm structures and the external world. Iteration 2 resulted in the reworking of the structure of norms, to better align with the structures presented i) in the data collected by Nadee et al. (2017), and ii) with my own experiences.

Although the flux model more appropriately considers the interaction (inter, intra, and inner) of between norm structures (i.e., mainly between informal, formal, and technical norms), there is an assumption that the flux model is driven by a conceptual goal, however currently no consideration has been given to i) how goals are formed and/or ii) how goals are communicated from the world to the concept layer. With iteration 3 the need for inclusion of conceptual goals is considered, and the pathway between the conceptual layer and the external environment is added to address these points.

5.3.1. Awareness of the Problem

Understanding the 'why' is critical to understanding the foci of a system, i.e., the reason why the system exists. In an earlier example we stated that in the 1960's America defined the intention to undertake a manned mission to the moon. On May 26, 1961, President Kennedy made a speech to the American people in which he encouraged the American nation "to commit itself to the goal of landing a man on the moon and returning him safely to earth before the decade was out". The intention (i.e., the informal norm) was clear, but the goal of space exploration (i.e., the concept norm) was not as clearly defined. We may naively propose that the primary purpose of a manned trip to the moon, requiring approximately 4.5% of the federal budget, was to support scientific discovery. Although many scientific discoveries were achieved, the suggestion of a manned flight to the moon was more likely driven by a significant fear that the U.S.S.R. was (at the time) more capable at manned space flight. The moon stood like a trophy of supremacy, which America (with a larger population and availability to resources) was not willing to give up to the U.S.S.R. Accordingly, the moon landings, across the late 1960s and 1970s, stamped the US as the authority on space flight – and no other nation attempted any moon landings (manned or unmanned) between 1976 (USSR - LUNA24) and December 2013 (China's Chang'e 3). US investment in it's space programme dropped year on year from 1970 until 2013. In 2014, however, after a successful Chinese unmanned moon landing, US space funding was suddenly increased to match China's significant rise to power. Currently the US are planning a return to the moon, i.e., by 2024, 'this time to stay - with the U.S. leading a coalition of nations and industry'. When America landed on the moon in 1969, the outcome realised the informal dream, however the US space programme continues still to allow the US to affirm American dominance in technological advancement – which is (I believe) the conceptual driver.

All systems (whether technical, organisational, or biological) undertake activities that help the system to achieve one or many, sometimes conflicting, goals. Goals are often to a specific key performance indicator (KPI), i.e., time, cost, money, satisfaction, however conflicting goals may focus on different KPI. The inclusion of system goal, and the consideration of conflicting goals/KPI, need to be incorporated at the core of the holistic model to support consideration of conflicting drivers, e.g., achieving customer satisfaction versus cost (and the desire to create profit). Accordingly, artefact 3 must include:

- How goals are influenced from external sources
- Consideration of multiple key performance indicators that might exist in goals.

5.3.2. Suggestion / Development

Although we encourage the use of Standard Norms Description (Liu and Li, 2014) for all norms, we propose the inclusion of key performance indicators in norms (particularly goal norms) to support quantifiable comparison of values. Many in society would claim that having a low level of Wealth (i.e., myWealth) will result in not being able to acquire basic deficiency needs, which in turn could impact wellBeing (which itself could impact happiness).

Accordingly you could state that society affirms that:

Whenever {myWealth >= £1M}
then <'I'>
is <'ought'>
to do <happy = 100>

In the example 'myWealth' and 'happy' are personal object attribute values, which change over time depending on the application of specific technical norms (object is <I>). In the example, I (the object) might decide to focus this nonsensical goal, i.e., to become a millionaire, with the aim to increase my own happiness. Some norms that increase the value of the variable 'happy' may reduce myWealth, and thus reduce the chance of the above goal being triggered. A conflict therefore exits between norms that achieved happiness (but cost money), which reduces myWealth, and the happiness gained by becoming a millionaire (as defined by society). The above goal norm, therefore, though tragically superficial in nature, acts as a guide to activity; and defines a quantifiable KPI that allows distinction in the drive between norms. If the define concept goal is defined as the primary goal, then norms that achieved happiness (but cost money) will be avoided, since such norms reduce myWealth and work negatively toward the triggering of the millionaire goal. If a technical norm reduces myWealth then I move away from satisfying the defined goal. If I undertake behaviour, however, that increases myWealth, i.e., toward the £1 million target (with KPI being money), then I assume (rightly or wrongly) that if myWealth = 1 million pounds my happiness will increase significantly.

Each person, organisation, or technical system may be driven and motivated by a completely different set of goals. One may be driven to make money. One may be driven by creation of customer satisfaction. One may be driven by happiness, etc. Irrespective of the system focus, the goals define the key performance indicators that ultimately drive selection of current norms, and act as a target in the management of norm dissonance; since the norms that support the goal should be used when conflict occurs (i.e., inter, intra, and inner norm conflict). This raises the question, however - **How does the system define new goals?**

The term 'meme' is mostly misused to represent a comical image supported by a phrase of dubious wisdom, yet the term was first coined by Richard Dawkins (1976) to represent a packet of information, normally concerning the transfer of behaviour or information between two people, that does not relate to genetic material or information. Dawkins, an internationally renowned geneticist, highlighted that it can take multiple generations to embody behaviour as part of the genome, yet an element of culture, or system of behaviour, can exchanged information much more easily; and proliferate between individuals without 'the messy business of procreation'. Memes include all aspects of culture and/or behaviour. As such all learnt material can be defined as consisting of memes, which are interpreted (via semiosis) by the viewer; based on pre-existing knowledge of the learner. Memes, which could be considered a collection of norms, represent the fundamental structures that define the cultural relationships that we have as nations, organisations, and individuals.

Within literature, consideration of culture occurs at these three levels, i.e., national level culture, organisational level culture, and individual level culture. The traditional view of culture (Taylor, 1871) applies at a national level, and relates to the summation of knowledge, beliefs, art, morals, law, custom, capabilities, and/or habits that exist in a specific society, e.g., national level norms, identities, and trends. Hofstede (2001), who primarily considered national level differences, defined culture as something that is "learned throughout a lifetime'; and therefore, should incorporate consideration of individual feelings, thinking, and actions. To support consideration of culture, Hofstede defined 'Hofstede's onion model of culture (see figure 5.7), like the work of Edward Hall, with values (belief and concepts) at the core of culture. Values, rituals, heroes, and symbols layers were defined, yet Hofstede importantly suggested that all layers could change overtime via the undertaking of practices.

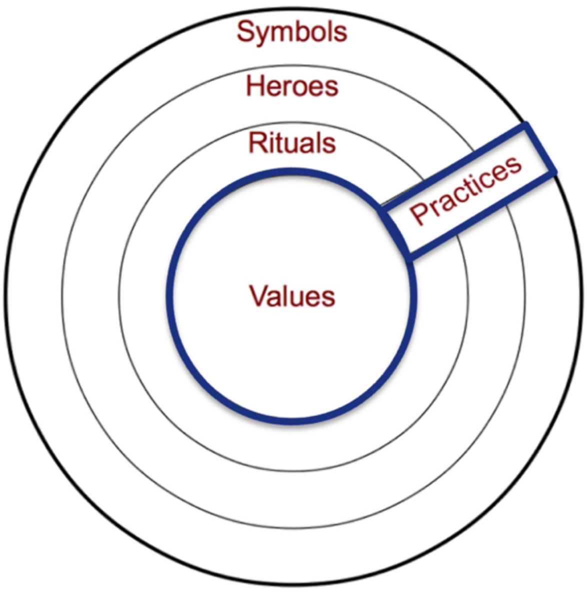


Figure 5.7 – Hofstede's onion model of culture (Hofstede et al., 1990: 291).

Organisational level culture relates to the collection of values, expectations, and practices that guide and inform the actions of a group of individuals with specific domains of business. Organisational culture is formed by individuals enacting organisational norms. Interestingly organisational norms can be influenced by changes in national level culture and/or the influence of dissonant individuals.

Individual level culture relates to 'like-minded individuals' – a concept that is not bound by any specific geographical location or national identity. Although it is easiest to conform to national and/or organisational norms, many individuals live in constant dissonance with the expectations and norms of the nation and/or organisation where they spend most of their time; and feel much more comfortable privately interacting with ‘like-minded’ people in clubs, societies, and/or online forums. Although the concept of national culture supports the macro study of nations and societies, Yoo et al. (2011) showed that use of national culture question constructs is inappropriate when testing individual level culture; and inappropriate modelling managerial and business situations (Kamakura & Novak, 1992). National culture cannot be used to reliably explain an individual’s behaviour (Straub et al., 2002), thus it is not right to use national culture values to predict an individual’s behaviour (McCoy et al., 2005).

When you accept a fact to be true, the chances are you believe it is true not because you defined the fact yourself, but because you learnt the ‘truth’ from someone else. Most norms, therefore, are decomposed memes. Accordingly, the ideas that we are taught as children, define the interactions that we can be part of (as in Kegans’ level 1) and the world model in which we live (as in Kegan’s level 2). As such, a culture might influence the aim and focus of an organisation (conceptual), describes what things are done (informal and formal), how things are done (technical), etc.

Interesting, memes also define the value that a specific society places of norms, and/or how society responds when a specific norm is triggered. For example, why in the west do we still believe that wealth will result in happiness (as in the example goal norm) despite considerable research suggesting that this is not true (Haidt, 2006)? Why is it that humans (due to the Halo effect) believe that attractive people are better in leadership roles? Why is it that every advert selling you something, continues to compound the norm that acquisition of products is the only way to achieve a specific social outcome (e.g., wealth, youth, happiness)?

The nature of human conformity (Sunstein, 2020) means that individuals are influenced by the structures of society and the opinions of others. As such, appreciation of memes, and social influence, is essential within the holistic information systems model is essential to not only capturing the distinct differences that exist in the context and situation, but also at support discussion concerning how the norms and response of individuals change to fit the context of influence.

Within the proposed holistic information system model (artefact 3) we incorporated a direct link from external world, in which floats an endless quantity of social memes, directly linking the concept norm structure to society. This direct linking of the concept norm structure (see figure 5.8) mirrors the thinking of Hofstede, within the onion model of culture (see figure 5.7). Over time the system – irrespective whether this is a person, organisation, or solution – incorporates, from the world surrounding it, several critical goals and/or requirements. Although the specific goals may be different in different countries, organisations, and setting, etc., goals are most often learnt (not logically formed) by decomposing memes. Interestingly, due to the direct learning of goals, we can infer that most system goals are not subjected to logical reasoning, and as such norms learnt directly from society will not be either i) logical in nature, or ii) in alignment with reality.

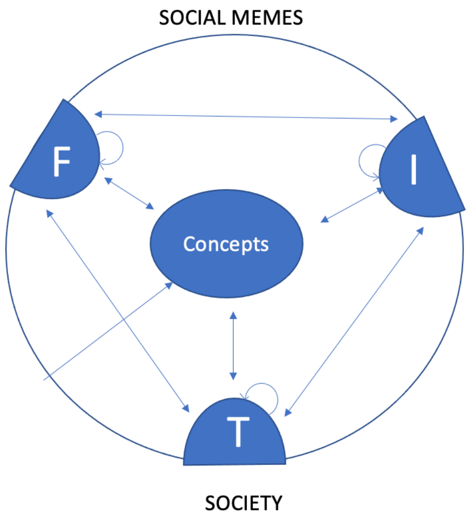


Figure 5.8. Iteration 3 Model - addition of Social Memes – supporting direct influence of C / T / F / I norm structures

5.3.3. Critical Evaluation

In the 'awareness of the problem' stage, for artefact 3, we stated that the holistic information systems model needed to consider both how goals are influenced from external sources and must consider the multiple key performance indicators that exist in goals. In artefact three we added a direct link between external world the conceptual normal structure. This allows goals to be learned, or taken, directly from society. As well as satisfying the first condition, this supports classroom consideration of social norms and influences, and allows students to appreciate that the context of use defines not only the definition of goals, but the definition of success.

I accept that a system might have many goals, and that goals might be in conflict, however consideration of KPI allows the system to focus on the desired system output. If the outcome is profit, then norms that result in high profit should be prioritised. If the outcome is customer satisfaction, then norms that result in customer satisfaction should be prioritised. If higher customer satisfaction also results in profit, then both goals can be achieved. Inclusion of key performance indicators within each goal norm supports the second condition, i.e., that multiple key performance indicators must be considered.

In this section I imply that a goal norm should include consideration of key performance indicators and consideration of object attribute variables, however this raises the question – **Where are system norms stored?** To be able to compare norms taken from decomposed memes against either i) current norms and/or ii) previously considered norms, there is an assumption that current and/or past norms are stored/ managed somewhere, i.e., a model of the system's perspective of the world is maintained separate from actual reality. This need is compounded by the awareness that all complex systems, for example humans, organisations, software all store (using different technical mechanism) and manage data, information, knowledge, and wisdom concerning current and past norms, i.e., to facilitate the effective processing of current activity. Storing information about the system's perspective of reality is also essential to support reflective learning, i.e., where a real-world output is observed and compared against the 'expected' inner world model. If reality does not reflect the system norm model of reality, then a subsequent change is needed to the capture and/or processing of inputs. If we do not store information about the expected outcome, then reflection and learning is not possible. Accordingly in artefact 4, and before consideration and resolution of dissonance in artefact 5, it is essential that the research considers the issue of an inner world model.

5.4. Artefact 4 – Adding an Inner world Model

5.4.1. Awareness of the problem

In iteration 3 we suggested the need to explicitly use norm statements. The introduction of norms (at conceptual, informal, formal, and technical levels) allows the system to capture a distinct record of system dynamics. Conceptual norms relate to 'why' something needs to happen. Informal and formal norms relate to 'how' it will happen, i.e., informal intentions and formal rules / plans. Finally technical norms relate to 'what' is done. The structure of norms, in iteration 3, was adapted from the domain of organisational semiotics, where Liu and Li (2014) define norms as having a condition which results in, assuming certain situations are satisfied, some outcome in an object attribute. For example, an informal norm might be:

Whenever {<I>.myWealth = £1M} then <I>.purchase(<dreamCar>)

From this norm it is not clear how the wealth will be obtained, but the norm suggests an informal intention of ‘what’ <I> object might do if I (the object) suddenly had a million pounds of wealth. Similarly, a conceptual norm might be written expressing:

Whenever {<I>.possess(<dreamCar>) = true} then (<I>.happy = happy + 10)

// though the scale and granularity of happiness would need additional critical consideration.
If obtaining happiness is seen as the core outcome then reverse inference allows us to assume that possessing a dreamCar i) exists as an object in the world, and ii) has been perceptually determined as being important. Use of norm logic, and introduction of goals, raises the question **- How does the system know about objects?**

In the following suggestion / development section I aim to consider this question to identify possible issues and identify potential solutions.

5.4.2. Suggestion / Development

Kegan (1982) described new-born infants (Kegan’s level 0 learning plateau) as “living in an objectless world, a world in which everything sensed is taken to be an extension of the infant” (p. 78). A new-born child may possess innate norms, such as pre-attentive visual processing, but it takes considerable time for a new-born child to appreciate the distinction between objects, and between objects and self. This distinction is essential to facilitate purposeful interaction with the world, and iterative development of object definitions is therefore critical to the development of our model. The internal model must distinctly define the objects that exist. In a technical solution, such as a piece of software these may be pre-determined, however a human and/or organisational system needs this process to be iterative, flexible, and extensible – i.e., to allow the detail and description of objects to change over time as the world changes.
By about 18 months (or two years) an infant has determined their own reflexes, the shape of basic world objects, and has determined the essential constructs that exist; allowing interaction between the world and self to occur (level 1 learning plateau). Between the ages of two and

approximately six years old the infant learns from interacting, mimicking, and experimentation. Interestingly however there is minimal separation in the child's world model between imagination and reality. Due to a naïve ontology of the world, entity categories and properties are not fixed. The infant therefore has a rough appreciation of how things work, but the function, properties, dependency, and scope of entity influence is not clear. Throughout this time there is limited distinction between imagination and reality since the limitations of reality have not been defined. Over time, however, as reality is reaffirmed, and the impossible is defined, ontology definitions become more durable. Object classifications, i.e., the purpose and relationship of objects, becomes more rigid, and the existence, importance, and use of object attributes and properties become more concrete. Accordingly, it is critical that the properties, and functional entities are effectively captured in the world model. Moreover, it is critical that the distinction of entities and the interaction relationships of entity types are captured within the world model. These relationships change over time as objects evolve and the relationship and dependencies between objects change, i.e., throughout the life of the system.

This need to incorporate fluidity raises three key points: Firstly, norms cannot rely on an external single world model, as a one-size fits all model of the whole world does not exist; hence a system specific model needs to be created within the system. Instead of relying on an externally pre-defined library of objects, a mechanism is required to iteratively develop/evolve internal norms. System norms are therefore guided not by the external world, but by an internally created/defined perception of the external world – suggesting the need to include (within each focal system) an 'inner world model'. Secondly, the model, to allow effective interaction with the external world, must dynamically represent i) entity structure – i.e. the scope and description of each entity, ii) consideration of entity methods – i.e. how the entity behaves when interaction occurs, iii) detailed information about all known instances of entities – the property values (that are known by the world), which impact the interaction and behaviour of the entity, and iv) the known relationships between object entities.

The previously used example norms, relies on the system having an explicit awareness of not only the objects within the world (e.g., <I> and <dreamCar>), but also a record of the attributes (e.g., wealth and happy), which exists within the object <I>.

To be effective, therefore, it should be pointed out that an explicit understanding of objects and attributes in the system scope is needed in order to support use of norm structures. It is not acceptable (or appropriate) for every norm structure (i.e., Concept, Informal, Formal, Technical) to have a record of the whole system domain, as this would result in an unmanageable level of complexity, resulting in issues of consistency and reliability. As such, the inner world model' needs to be a single, available, yet distinct source of 'truth' for all norm structure (conceptual, informal, formal, and technical) in the system. The existence of all norms can be stored as part of the 'inner world space', however a flag concerning use of 'current' norms should be recorded in each of the norm structures, i.e., a recognition that this is currently the norm that i) best aligns with other norms, whilst ii) most closely satisfying the system goals. In figure 5.10 the reader can view the suggested addition of a simple inner world model, which is updated as memes are decomposed from the external environment and passed to the norm structures. The norm structures themselves will be responsible for dealing with conflict and reasoning, however, should not be the source location where norms are stored. the bidirectional arrow linking each norm structure to the external environment also suggests that changes in current norm and/or reflection of current activity also pass by the inner world model; thus, supporting potential reflection and learning mechanisms (to be considered later).

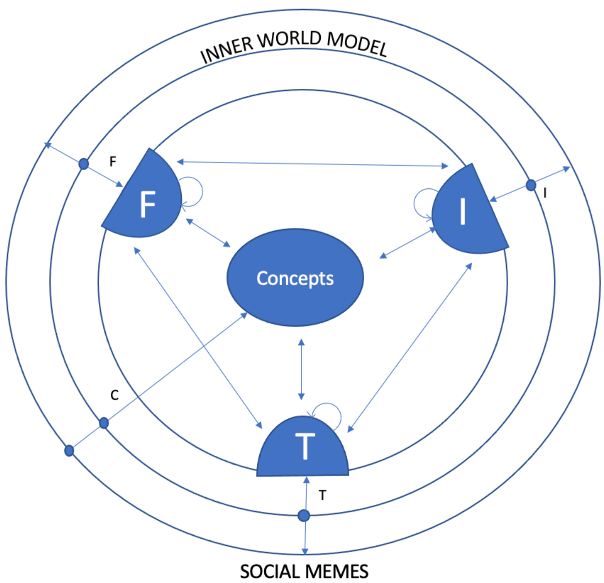


Figure 5.9. Iteration 4 Model – Addition of 'Inner World Model' - storing all norm structures

Common sense suggests that a system should not contain information about all possible objects in the entire world (as not all objects are experienced by the system). As such the system's 'inner world model' is neither meant to be an exhaustive and/or unquestionable accurate representation of the real-world. The system ‘inner world model’ requires only information about norms, objects, attributes, values, and relationships that supports the system to effectively undertake its goals in the system scope. The ‘inner world model’ should therefore aim to contain information about the objects, attributes, and values that are considered in the norms represented by the systems.

A software system, for example, represents (and supports) specific objects, processes, and attributes (variables), and relationships that are contained within the requirements document. Information about non-essential objects and attributes would be considered a waste of memory and would not be included within the data structure. Similarly, it is critical to include consideration of only objectives and attributes that link to system norms. If a new norm, however, references to an object that is unknown in the system ‘inner world model’, then, to allow comparison of norms, it is critical that the ‘Inner world model’ creates a new object (even if little is known about the object structure, attributes, or function). Over time, we would hope that the system will gain additional norms relating to that object, allowing a fuller understanding of the object attributes, values, and processes, which can be augmented in the system model. A full knowledge of all objects, however, should not be presumed before use of an object is considered.

If an object attribute value changes in the real-world, but the system is not aware of this change, then a system model should not be condemned if the system does not represent the ‘truth’ – as it represents the known truth, which itself is perhaps of more importance, as it allows us to consider the accuracy of system knowledge. Moreover, although it is ideal for the system to have an up-to-date and truthful understanding of the world, the appreciation that multiple systems might possess distinctly different understandings of the same domain is essential to effectively express the complexity and interaction of complex systems.

By representing the system’s perspective of reality, the ‘inner world model’ a number of critical points should be considered, i.e., i) real world object attribute values are explicit, i.e. a true realism stats exists; ii) the inner world model scope, i.e. coverage of systems, attributes and value, is dependent on the function of the system; iii) not all systems have an equal appreciation of reality, and iv) each system potentially has an ‘inner world model’ that is different and unique; resulting in some interesting systems conflicts as to how truth should be defined.

In the following sub-sections, the research will consider in more depth two issues concerning, i) possible 'inner world model' ontology, and ii) norm believability, which are critical to definition of the inner-world model.

Possible 'Inner World Model' Ontology

Systems with internal methods (such as people), if placed in different contexts, and given a different set of conceptual goals, will perceive the world differently; and will place different importance on a objects, rules, relationship, restrictions, and cause and effects in the inner world model. As such each focal system needs to create its own definition of what exist, how things relate, and what is important.

The field of metaphysics, i.e., the category of how things are, is one of the oldest known to science and philosophy. Aristotle (who lived 384-322 BC) distinguished 10 basic entity types, i.e., Substance, quantity, quality, relation, place, time, situation/position, condition/state, action, and passion. Kant defined four categories: Quantity, quality, relation, and modality. Guarino identified eight categories, which consist of: Individuals, properties, relations, classes, structures, quantifiers, facts, and negation - many of which are still commonly used in the modelling world. Most metaphysical structures relay on a fixed pre-defined definition of categories. With limited solutions consider the need for a balance between management of world structure and system flexibility, however it is critical to support the ability to evolve to change (Grzybek, Xu, Gulliver & Fillingham, 2014). It's critical that the semantics of the system world is detailed enough to facilitate interaction and support system functionality, yet flexible enough to allow change – since change is the only constant. Grzybek et al. (2014) whilst seeking for a similar balance in the description of physical built environments, i.e., the description of physical buildings used in the process of construction, identified conflicts between i) the description of domain specific detail and generic applicability, and ii) the description of static physical and dynamic (process) related system activity.

Grzybek et al. (2014) suggested that systems should have a personalised ontology – aligning well with our need for each system to have its own world model. Moreover, Grzybek et al. proposed seven steps, adapted from the work of Noy and McGuinness (2001) to support the development of a system world model. These steps are: 1) Determine the Domain and scope of deontology; 2) consider reusing existing Ontologies; 3) innumerate important terms in the ontology; 4) determine the classes and the class hierarchy; 5) define the property of classes; 6) define the facet of the properties; 7) create instances.

If previous object entities and/or parameters, or relationship types, already exist in the world space, then these should be re-used. If, however, no suitable ontology already exists, then the system needs to move to step three to determine what is required, i.e., the listing of important semantic terms that should be included in the ontology. The list must include all parameters and concepts critical to the definition and use of the entity. The fourth and fifth steps aim to arrange these concepts into a coherent conceptual model, with step four focused on the definition of entity concept types (also commonly referred to as "object classes") and a class hierarchy, and step five focusing on class properties.

I initially investigated several technologies that might support development of an inner-world prototype, however no single technology solution could be identified; and there is a need to combine several current data solutions to support the required functionality (e.g., dynamic object / attribute / values definition, dynamic modelling of object attribute relationships, a norm or programming focus, etc.). Although development of inner world ontology might be used to develop an 'inner world model' data structure, it was defined as beyond the scope of this project.

Norm Believability

A post-truth culture exists when "objective facts are less influential in shaping public opinion than appeals to emotion and personal belief" (Oxford Dictionary). In an increasingly 'post'-truth society, poor critical discussion is often driven by how people 'feel' about specific truths. Discussing the confusion between facts and opinion is facilitated by inclusion of the 'inner world model' within all systems.

Interestingly, most real-world objects and attributes can be explicitly measured, e.g., the switch is on or off, the chocolate weighs 100 grammes, the tree produces cherries. In such situations what someone believes to be true and/or what they feel about the real-world, does not change the world state. I might believe the tree to be an apple tree, yet my belief will never change the DNA of the tree, or the fruit that will be produced. Confusion occurs, however, when an inappropriate level of believability is assigned to specific norms, i.e., if either i) when people accept a norm without question, due to the believability of the norm teller, or ii) when people dismiss empirically measurable facts, because they don't understand the logic of reasoning.

If someone says ‘I heard that so-and-so said X and Y, so X and Y must be true” then the norm is being assimilated not based on the validity of the norm’s truth, but on the believability of the person speaking the norm. For example, folkology states that Abraham Lincoln never lied. If this, and nothing else, is known to the reader, then the reader might believe the statement written in figure 5.10. The content of the quote itself makes perfect sense, however the association of a quote about the internet (which was initially invented in 1969 – i.e., 104 years after Abraham Lincoln’s death) makes the validity of the statement ludicrous. The irony that Abraham Lincoln never lied, yet the quote could never be true, makes the quote funny, i.e., at least for those that get it.

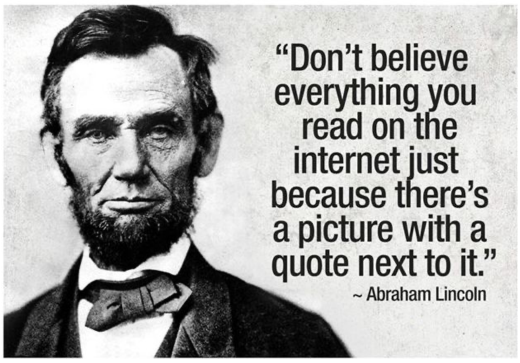


Figure 5.10. An ironic example of ‘I heard that so and so said X and Y’ – but this one ironically makes sense!

To trigger norm conditions, we need to be able to define with confidence when a state change has occurred. As such it is critical that the system can identify when a norm condition has been satisfied. The issues of belief (subjective) and believability (objective), however, are essential for identifying whether the system consider a norm to be true or a lie. Accordingly, it seems that the issue of norm believability is something that needs to be critically considered when defining the inner world model.

In the example norm it was stated that:

Whenever {<I>.possess(<dreamCar>) = true} then (<I>.happy = true)

This norm was defined not because of statistical analysis of empirical data, but as a lazy summary of a social stereotype, i.e., that people who are living the dream life (at least as projected on TV and social media), and possess their dream items (e.g., a dream car), always seem to be (at least on TV) to be happy. Since this norm is not empirically validated in my experience, the twinning of all norms with two piece of meta-data is required. The first piece of meta data should inform the system about whether the system holds a strong belief in the norm, e.g., I strongly believe in gravity and/or that the world is a globe. The second piece of metadata should contain information the system about whether the source of the norm has high believability (the source can be trusted). If norms fail to consider both belief and believability, then the system in unable to distinguish between truth that are undesirable yet reliable, and truth that are desirable yet unreliable.

Place yourself in the mind of someone from the mid sixteen hundreds. If the authority that governed the destination of your eternal soul (i.e., the church) informed you that the earth was at the centre of the universe (the view formalised by Aristotle), then would you believe a random polish priest (i.e., Copernicus – 1473 to 1543 CE) who claimed that the Earth orbited the Sun. The church was seen as the authority of truth, it had high believability, as such most people believed strongly in the Aristotelian view of the universe. Over time, however, additional empirical evidence was collected (by both Galileo and Kepler) concerning the absolute real-world truth. This evidence supported the development of mathematical equations and prediction orbital mechanics of the universe. Since predictions came true, the believability of the scientists increased over time (as it became possible to accurately predict reality using the orbital models). Galileo (1564-1642) was persecuted by the Church for defining these models, however his belief in their truth was high, and the scientific method he had used to collect and interpret the data was (to him) more believable than the unvalidated statements made by the church. In 1687 Isaac Newton published 'Principia', based on Galileo and Kepler's equations, which placed the final nail in the coffin of the Aristotelian view of the universe. Newton's 'principia' also presented his law of universal gravitation, which helped explain the motion of planets. As norms are formed that explain the nature of reality, our model of reality is augmented. The introduction of gravity (latter reconsidered by Einstein's theory of relativity) provided a description of the mechanism that explained the interplay of planets.

If a respected individual told you that something is true, then you are more likely to believe the norm without question, since the person has a high level of believability. Six points are raised from this discussion, i.e., i) belief is not categorical in nature and must be considered as a scale, ii) belief changes over time, iii) a change in belief can impact the use of norms within a system, iv) it is possible (though less likely) for someone to hold a strong belief in a norm that is taken from an unreliable source (i.e., has low believability); v) it is possible to have a low level of belief (though again less likely) in a norm that is taken from a reliable source (of high believability); and vii) the believability of a specific source can change overtime as a result of the validation of claims – i.e., the alignment between source claims , as real world object states change over time.

If source believability is high and belief is high, then the norm is strong, and it is less likely that the norm will be overturned (i.e., a shift from green) without a change in the believability of the source and/or introduction of an alternative norm that better aligns to real world facts. If the belief is low and the believability is low, then it is likely that the norm will be replaced unless the believability of the source can be improved (i.e., finding additional sources that support the norm and/or by proving empirically that the norm aligns to real-world facts). If the belief is low but believability is high (see table 5.1) then the strength of the norm is weak. It is likely, however, that if an alternative norm is not selected, the belief will increase in strength over time. If the belief is high but the believability is low, however, then it is likely that the candidate will welcome replacement norms that have a source that has a higher believability.

Table 5.1 - Norm stability (Belief level v Source believability level).

		Believability	
		High	**Low**
Belief	**High**	Strong	Weak
	Low	Weak	Replace

Discussion confirms that belief and believability, cannot be ignored in our system model, as it supports consideration of 'subjectivity'. It is important that people do not rely without question on the current conclusion of science; even though few scientists would say that something is 100% reliable. It does show, however, that belief and believability must be defined on a scale to allow consideration of doubt. Since the KPI of certain norms will relate to subjective measures, e.g., well-being, it is critical that the model is able to represent subjectivity – even if belief and believability is very low. For example, if two norms suggest a conflict between a specific entity attribute value, for example the earth rotates around the sun or the sun rotates around the earth, then the internal model (unlike reality) can contain both norms. Belief and believability, and alignment to system goals, can then be used to distinguish the likelihood of a specific norm outcome being selected. The system will most likely apply the norm with the highest belief. This higher level of belief may be due to a history of confirmation; however, a lack of confirmation may result in a drop in belief - subsequently also resulting in a reduction in the believability of the norm source.

5.4.3. Critical Evaluation

The consideration of norms (conceptual, informal, formal, and technical) allows the system to capture a distinct model and record of system dynamics. In this artefact 4 we stated that constructivist learning occurs because of interaction between the system and the real-world models, with the inner world model defining the system's dynamic perspective of reality. Interestingly, this model needs to be fluid, which suggest that i) norms cannot rely on an external library / ontology definition of the world model, as a one-size fits all catalogue of objects cannot exist; ii) the model must dynamically represent entity structures – i.e. the scope and description of each entity, ii) the model must dynamically represent entity methods – i.e. how the entity behaves when interaction occurs, iii) the model must dynamically represent detailed information about all known instances of entities – the property values (that are known by the world), and iv) the model must dynamically represent known relationships between object entities. Although a range of solutions exist that solve some part of the problem, to the best of my knowledge, no single technology is currently able to address all these requirements. This is an interesting problem, however identification of a technical solution to the data management issue was defined as beyond the scope of this thesis.

The fourth artefact model (see figure 5.9) suggests the addition of an 'inner world model' between the system boundary and the reasoning layer, i.e., where formal, informal, and technical norm structures are positioned. When specific norms are taken from decomposed memes, they pass by the model on the way to being critically considered. If norms already exist, then no additional norms need to be added – yet the belief and/or believability norm meta data may be adjusted. If, however, a new norm is identified, then this can be added to the inner world model; and any new objects, object instance, attributes, values, relationship are added to the model to ensure effective management of the new norm. If a new norm better represents reality, then belief in the new norm may rise above old norms. If a new norm conflicts with other norms (either inter, intra, or inner) then some form of dissonance resolution is required. This will be considered in artefact 5.

To support development of a resolution mechanism, however, I introduced the dynamic subjective ideas of belief and believability, which are essential for identifying whether the system considers a norm to be true or a lie, which is therefore useful in the resolution of norm conflict.

5.5. Artefact 5 – Handling Norm conflicts (Inter / Intra / Inner)

5.5.1. Awareness of the Problem

Artefacts 2 to 4 have assumed that a dissonance is created in the system model when norm conflict (inter, intra, or inner) occurs, and that a mechanism is required within the norm structure to reduce or remove this dissonance. Cognitive dissonance is a term used to describe the uncomfortable feeling that exists when two conflicting beliefs, values, or attitudes are held in parallel. If an external belief or attitude conflicts with the internal belief within our system, then a dissonance exists. To resolve the conflict either i) the system norm must change, i.e., to match the external norm, ii) the external norm must change to match that of the internal, or iii) the system must dismiss the external norm.

In certain situations, a conflict with the external environment could be seen as a good thing. For example, if the world commonly applies conceptual, informal, formal, or technical norms that conflict with our system norms, yet our system norms better satisfy the goal KPI, then this may be a difference that should be proudly maintained - assuming human rights and ethics are not ignored (considered in artefact 8). Moreover, for example, if the technical norms (i.e., 'how' something is done) is superior in our system to other external systems, then the inter-conflict is positive. If, however, there is an inter-conflict that suggests the technical norms outside our system are better than those used inside our system then there exists a negative dissonance; and a change should be considered towards use of the external technical norm. In this artefact I will aim to address the issue of conflict resolution.

5.5.2. Suggestion / Development

The dilemma is what mechanisms should be used to determine which of the two norms – i.e., the current norm (CC) or the new norm (NC) – most aligns to the goal norms defined in the conceptual component. I propose the adaptation, and incorporation, of a model called the 3D-RAB model. The 3D-RAB model was first proposed by Wiafe, Nakata, and Gulliver (2011) as a mechanism to analyse and implement behavioural change within persuasive technologies.

Cognitive dissonance theory primarily focuses on the relationship between behaviour and attitude. In the context of persuasive technologies, Wiafe et al. aimed to align users' current behaviours and attitudes towards a target behaviour - since having the 'right' attitude is a positive step, but arguably pointless if this does not ultimately result in the target behaviour. Wiafe et al. proposed three factors that should be considered: attitude towards target behaviour (ATTB), attitudes towards changing/maintaining current behaviour (ATCMB), and current behaviour (CB). Attitude towards target behaviour (ATTB) is defined as the like or dislike of a target behaviour (either positive, negative, or neutral). If someone has a positive attitude towards the target behaviour then, based on cognitive dissonance theory, the individual is more likely to change any negative current behaviour towards the positively considered target behaviour. If someone has a negative attitude towards the target behaviour, then they are not only less likely to undertake the target behaviour but are also more likely to develop a negative attitude towards change toward use of the positive behaviour. Current behaviour (CB) is defined as the existing action of a person in relation to the environment. Current behaviour could be conscious or subconscious and/or voluntary or involuntary. If the current behaviour is the target behaviour, then dissonance may still exist, however this depends on the individual's attitude towards the target behaviour and/or their willingness to maintain that behaviour. ATCMB relates to Attitude Towards Change (if behaviour is negative), or maintenance of current Behaviour (if behaviour is positive – i.e., target). ATCMB is the measure of agreement or disagreement of the person in relation to a particular change or maintenance in behaviour (either positive, negative, or neutral). Someone may be positive towards the target behaviour, yet they may find themselves unable to maintain the current behaviour. This state of dissonance is familiar to most people who have tried to do more regular exercise. The target behaviour is clear – i.e., regular exercise – and the attitude towards undertaking that behaviour is often positive. An initial change in behaviour might occur, however due to the uncontrollable pressures of time (or in my case fundamental laziness) the target behaviour is only maintained for a short while, however a consistent change in behaviour is rarely maintained. Although there exists a positive attitude towards the target behaviour, the attitude towards maintaining the target behaviour is not strong enough to resist the 'immunity to change' (Keegan and Lahey, 2009). The topic of immunity to change was considered in an excellent book by Robert Kegan and Lisa Laskow Lahey, which links the need to change to Kegan's learning plateaus, however this will not be considered in any detail in this thesis.

Within the 3D_RAB model Wiafe et al. used ATTB, ATCMB, and CB as dimensions of change in cognitive states (see table 5.2). A change from positive to negative in one-dimension results in a shift from one cognitive state to another (see table 5.2). The resultant eight states each differ significantly in the level of stability and level of cognitive dissonance that exists. An individual in state one is currently involved in positive target behaviour, their attitude towards current behaviour is positive, and their attitude towards maintaining the current behaviour is positive. An individual in state eight is currently involved in negative target behaviour, their attitude towards the current behaviour is negative, and the attitude towards changing their behaviour is negative. Both states 1 and 8 are stable, and no cognitive dissonance exists. Although states 2 to 7 were all deemed as unstable, Wiafe et al. assigned differing levels of dissonance and stability to each state; with transition between each state subsequent as a result to change in the individual's behaviour or attitude (either externally mandated / influenced or internally determined). Individuals in states 2 to 7 (see table 5.2) therefore have different levels of dissonance as a result of their positive and negative CB, ATTB, and ATCMB.

Table 5.2. 3D-RAB states.

State	Current behaviour (CB)	Attitude towards current behaviour (ATTB)	Attitude towards maintaining / changing target behaviour (ATCMB)	Cognitive Dissonance	Stability
1	+	+	+	None	Stable (+)
2	+	+	-	Weak	Unstable (+)
3	+	-	+	Moderate	Unstable (-)
4	+	-	-	Strong	Unstable (-)
5	-	+	+	Strong	Unstable (+)
6	-	+	-	Moderate	Unstable (-)
7	-	-	+	Weak	Unstable (-)
8	-	-	-	None	Stable (-)

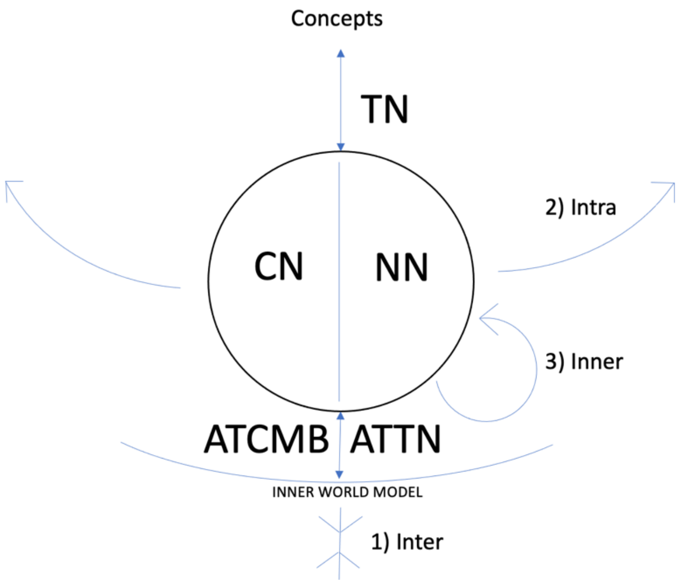


Figure 5.11 – Suggested adaptation of the 3DRAB model, for use for all norm types.

We propose using an adapted version of the same mechanism for managing the dissonance between different norms, however instead of using a three-dimensional space, we propose the consideration of five factors: Current Norm (CN) - stored in norm structure, New Norm (NN) - stored in norm structure, Target Norms (TN) - stored in concept norm structure, Attitude to Target Norm (ATTN) - stored as meta-data in 'inner world model', and Attitude towards Change of poor behaviour or Maintenance of good Behaviour (ATCMB) stored as meta-data in the 'inner world model'. ATTN and ATCMB are measured as being either positive (+) or negative (–). The value gained by adopting the Current Norm (CN) or New norm (NN) is calculated using a ratio that represents both i) whether adoption of the norm will result in a change that either moves towards (+) or away from (-) satisfaction of the target goal, and ii) the proportional of the size of the change towards or away from a point where the goal norm is triggered at a value of 1. Let's assume, for the sake of description, that the system goal (as previously considered) is:

> Whenever {myWealth >= £1M}
> then <'I'>
> is <'ought'>
> to do <happy = 100>

If my current norm (CN), which I like and do not wish to change, conflicts with the target norm (TN), i.e., the outcome of the CN results in MyWealth = MyWealth – 100, then the current norm would be deemed as i) negative - as the outcome in MyWealth moves away from the desired KPI goal of the target norm, and ii) would have a value ratio of 0.0001 – due to the loss of 100 being 0.01% of one million. If a new norm (NN) were proposed, which I do not like, resulted in an increase of MyWealth (e.g., MyWealth = MyWealth + 100000) then the new norm (NN) would be seen as i) positive – as it aligns to the KPI goal of the target norm, and ii) has a ratio value of 0.1 (as 100000 is 10% of the million needed to trigger the goal norm). CN and NN values can be graphically positioned (see figure 5.12), i.e., with dimensions of ATCMB (+/-), ATNN (+/-), and value defining the three-dimensional space.

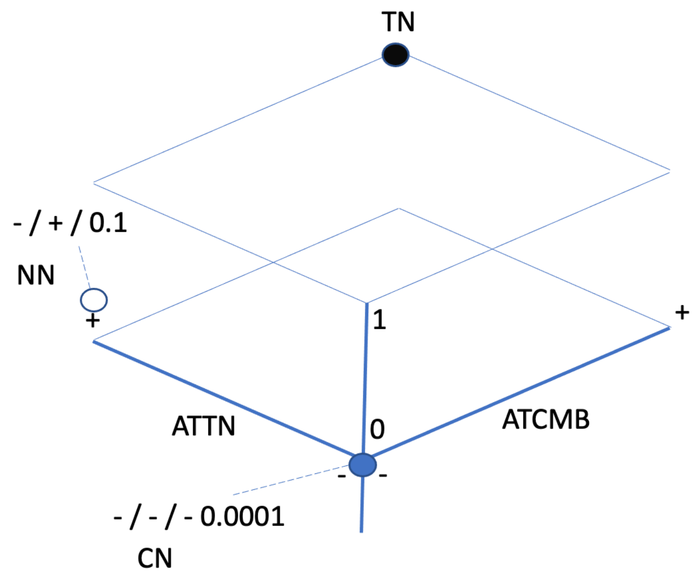


Figure 5.12. Artefact 5 Model – Value space.

If ATCMB or ATTN variables are considered by a system to be of different importance, then a different value can be assigned to represent the distance between – and + points for the two variables (termed ATCMB_gap and ATTN_gap). In our example both ATCMB-gap and ATTN_gap are considered to be the same; and both are defined the value of one. The best outcome, for this specific KPI, can be calculated by determining the Euclidean distance from position + / + / +1 (the TN goal) in 3-dimensional space. In our example the current norm has a negative ATCMB (as my attitude to changing the current negative norm, i.e., towards target behaviour, is negative), the ATTN is negative as the current norm is working away from the TN KPI trigger magnitude, and the current norm has a negative value of -0.0001. Accordingly, the CN is positioned at space position of - / - / 0.0001 (see figure 5.12). The new norm has a negative ATCMB (as my attitude to maintaining the new positive norm is negative), ATTN is positive (as the new norm outcome does work towards the TN KPI goal trigger point), and the norm has a value is 0.1. Accordingly, the NN is positioned at space position - / + / 0.1 (see figure 5.12). Accordingly, the Euclidean distance (d) can be measured between CN and NN norm points and + / + / +1 in the three-dimensional space; where $d = \sqrt{[(ATTN\_gap)^2 + (ATCMB\_gap)^2 + (value)^2]}$. The distance between CN and the goal location – representing the level of dissonance for the current norm is 1.732. The distance between NN and the goal location – representing the level of dissonance for the new norm is 1.28.

If the decision wishes to incorporate the norm belief and/or believability, then I suggested dividing the dissonance score by the outcome of belief multiplied by believability; where belief and believability are assigned a value 0 to 1 respectively represented no belief/believability and total belief /believability. In our example, and for the sake of simplicity, the score for the current norm (with both belief and believability scopes being equal to 0.8) would result in a final dissonance decision score of 2.69. It is interesting to note that the dissonance has increased to reflect the doubt that exists in the norm outcome. The new norm is deemed better than the current norm unless the belief / believability scores drop – e.g., both belief and believability scopes dropping below 0.689 in the new norm – resulting in a dissonance greater than the new norm. If the multiplier of believe and believability is low (due to a lower level of belief and believability) then the dissonance increases, and the outcome might change.

In our example we can see that neither of the norms is ideal (see figure 5.12), however we can see that – for this specific KPI goal and assuming belief and believability is equivalent between the two norms – the best norm to select is the new norm. To reduce dissonance, I could try to change my attitude to change or my attitude towards maintaining the target behaviour - maybe by associating a reward with this the target behaviour. Alternatively, if belief and/or believability is being considered – I could attempt to improve my belief in the new norm. Or, if nothing else works, I could seek out an alternative new norm. Interestingly, if a new or multiple target norm KPI were used, then the distance to the goal would reset, and a different best outcome (despite the same conflict of norms) would be decided.

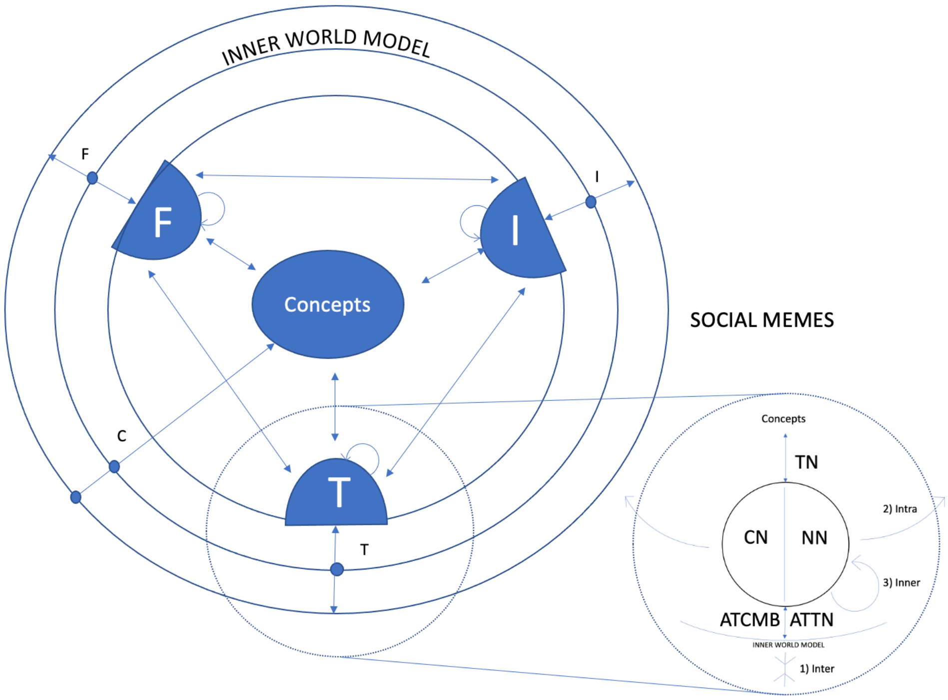


Figure 5.13 - Artefact 5 Model – Addition of Handling of Norm Conflicts.

The proposed adapted 3D-RAB model should be used <u>within all norm structures</u> (see 5.13) to compare all identified inter-, intra-, and inner- conflicts against related target norms in context of attitude towards change. If no clear resolution can be made, then conflicting internal norms should be flagged for possible replacement ASAP. If change is externally mandated, however, then adoption of the new norm is impossible. Accordingly meta data is required to clarify whether norms can be removed. Recursive checking of all changes is required to ensure alignment where possible.

5.5.3. Critical Evaluation

Within artefact five I suggested a possible mechanism for management of conflicting norms in the holistic information systems model. This mechanism, originally proposed by Wiafe, Nakata, and Gulliver (2011), in a simpler form, allows current and new norms to be critically considered considering the balance:

- Current Norm (CN) - stored in norm structure,
- New Norm (NN) - stored in norm structure,
- Target Norms (TN) - stored in concept norm structure - with specific consideration of the norm KPI and trigger value,
- System Attitude to Target Norm (ATTN) - stored as meta-data in ‘inner world model’,

- The Attitude towards Change of poor behaviour or Maintenance of good Behaviour (ATCMB) stored as meta-data in the 'inner world model'.

In sum, the proposed mechanism dynamically determines a dissonance score outcome based on target norm definition, attitude significant (ATCMB_gap and ATTN_gap), and norm belief and believability; yet dependent on the existence of the inner-world model and meta-data relating to system attitudes. If this adapted 3D-RAB model were included in all norm structures, to manage the minimisation of dissonance in local norms, then a constant flux of change would occur in the use of current norms because of external influence (inter-norm conflict) and/or internal proposed changes in object-attribute values (intra- and inner-norm conflict).

5.6. Model Evaluation

In this section I will undertake a brief DSR artefact evaluation to assess whether artefact five (as-is) is able to satisfy the requirement, i.e. to support – within one model - the teaching of the information system concepts currently being presented in MM258 models, i.e. 1) Nadee et al.'s (2017) dual aspect model which introduces students to the idea of business norms and norm conflict, 2) Venkatesh et al.'s (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex dependency model considering technology system acceptance, and 3) Pankratz and Basten's (2013), which introduces students to a complex theoretical failure model.

Dual-aspect model

Since the dual-aspect model was used as the DSR kernel theory, the detailed consideration of norms, and norm conflict are inherent in this model. Consideration of this point is also considered in the conclusion of artefact 2. One issue that could be raised, particularly in artefacts 2 to 5, is the high level of complexity that occurs in the interaction between systems. Currently direct interaction occurs at all norm points, however i) systems normally have clear channels through which interaction occurs, and ii) a free-for-all form of interaction adds a level of complexity to the model that chapter 4 results suggest may be confusing to students. It would be ideal to reduce the simplicity of the system interaction by considering whether the IPO model could be used as the basis of interaction.

UTAUT2 Factors

The following content considers whether artefact five can effectively represent UTAUT2 concepts. To better understand the mapping between UTAUT2 factors and norm types, I asked Dr. Winai Nadee (the creator of the dual-aspect model – i.e., artefact 1) how he would map the different UTAUT2 factors to the dual-aspect model (see figure 5.14). Winai's suggested mapping is interesting, and highlights a good spread of interaction, including direct connect with the concept layer, which was left unconsidered in the original model description.

Performance Expectancy (PE) can be defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davies, 1989). This condition is covered in artefact five by use of norm statements, since informal (intended), formal (planned), and technical (actual) norms can represent what outcomes in object attribute value (i.e., benefit) are expected in the system in a certain situation.

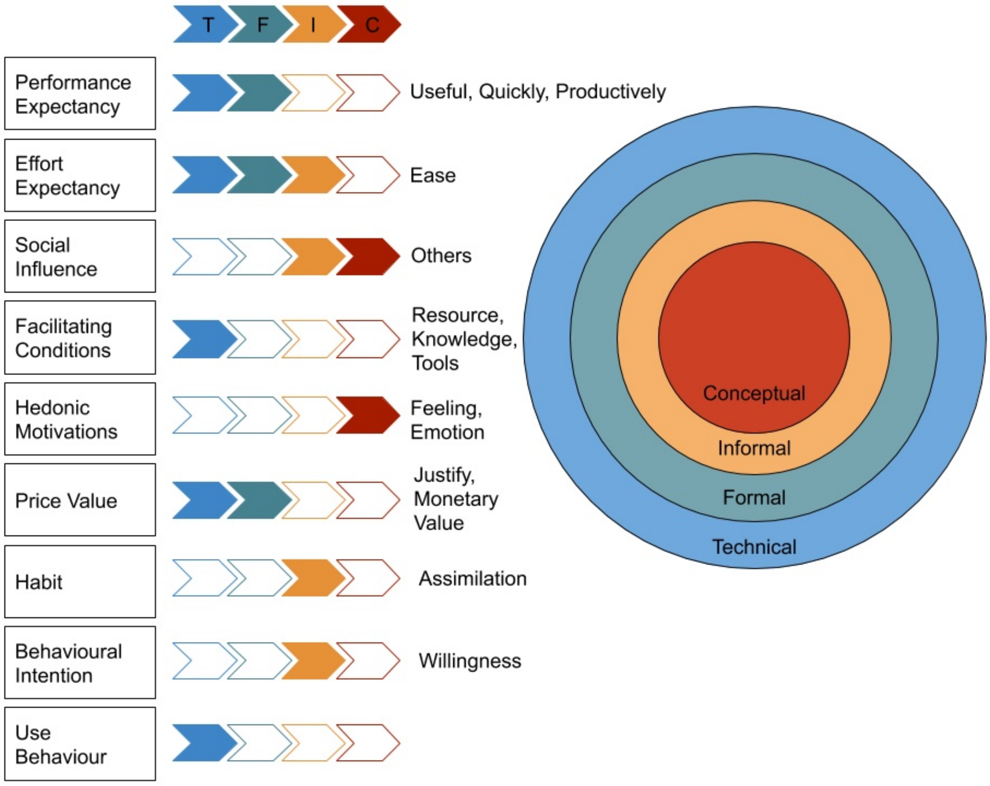


Figure 5.14 – Winai Nadee's allocation of norm layer linked to UTAUT2 variables.

For example, two formal norms might state that:

Whenever {<I>.use(<ebay>) = true} then (<I>.possess(<newBook>) = true}

Whenever {<I>.possess(<newBook>) = true} then (<I>.happy = <I>.happy + 20}

In our model we also include consideration of PE in informal norms, i,e, intentions. Use of norms can i) provide considerable detail about perceived expectancy, but ii) also consider whether this benefit is broken in to conceptual, informal, formal, or technical parts.

Effort Affordance (EE) can be defined as “the degree to which a person believes that using a particular system would be free of effort” (Davies et al., 1989). As in PE, EE can be represented in artefact 5 in informal, formal, and technical norms. All norms can be directly influenced by external sources (unlike the dual-aspect model). For example:

Whenever {<I>.use(<ebay>) = true} then (<I>. MyWealth = MyWealth – 50)}

By linking actions to expected changes in object attribute values, we can effectively consider the efforts that occur, and can (over time) predict this to increasingly high level of accuracy.

Facilitating Condition (FC), defined as “the perceived ease or difficulty of performing the behaviour” (Ajzen, 1991), is like EE; however, FC is applied, as suggest by Winai Nadee, primarily in the technical norm structure.

Social Influence (SI), defined as “the person’s perception that most people who are important to him think he should or should not perform the behaviour in question” (Fishbein and Ajzen, 1975). Winai Nadee suggests that social norms influence only informal and conceptual levels (see figure 5.14), which is interesting in context of the dual-aspect model, since there is no mechanism in the dual aspect model to link the external social space directly to these norm layers. I suggest that social influence can influence all types of norms, as the people around you will influence tools used and rules followed, as well as unplanned intention and definition of goals. Unlike the dual aspect, however, our artefact 5 has a direct connection between all norm structures and external influence, which better allows discussion as to how external social influence can directly impact norms, e.g., new laws, societal expectations, etc.

Use Behaviour, which relates to the outcome of the system, can be define in artefact 5 by considering technical norms, as suggested by Winai Nadee (see figure 5.14), however explicit consideration is not currently considered in artefact 5. Accordingly, explicit consideration of behaviour is needed (see artefact 7).

Habit, defined as "the extent to which people tend to perform behaviours automatically because of learning" (Venkatesh et al., 2012). Habits can be considered as automatic learnt behaviour, i.e., at a national, organisational, or individual level. This can be considered in the current artefact as norms structures can be used to represented learnt content. Habits are normally learnt as the appropriate automatic response in a specific context. As such, following a habit requires limited cognitive processing. Although we behaviour in artefact 5 is driven by current norms, the artefact fails to consider behaviour explicitly, or distinguish between reactive, automatic, and planned responses. Accordingly additional consideration of thought, learning, and behaviour (unconscious reaction, automatic reactions and behaviour, learning, and logical reasoning) all need to be considered in a future artefact (see artefact 7).

Hedonic motivation, defined as "a user's perceptions of the fun or pleasure derived from using a technology" (Venkatesh et al., 2012), can currently not be represented by artefact five, as no consideration has been given to emotions or feelings – the existence of which is critical to consideration fun or pleasure. Accordingly, this needs to be highlighted and critically considered in a future artefact (see artefacts 8 and 9).

Price Value, defined as "The cost and pricing structure of using a new IT" (Venkatesh et al., 2012). Price value is considered in artefact 5. The adapted 3D-RAB model allows the price value of norms to be critically compared considering the Current Norm (CN), New Norm (NN), Target Norms (TN), Attitude to Target Norm (ATTN), and Attitude towards Change of poor behaviour or Maintenance of good Behaviour (ATCMB). As part of this resolution process a value is create, to determine how closely each norm (i.e. CN or NN) is to triggering the TN outcome. Moreover, a single dissonance value is created to support selection of the best outcome in context of the goal, belief, and believability of norms. This structure aligns well with price value, and as such support consideration of this factor.

Pankratz and Basten

Pankratz and Basten conducted a systematic literature review of 15 IS failure case studies, and, using thematic analysis, proposed 54 distinct failure factors (see appendix A), which they mapped within a theoretical multi-dimensional model consisting of 10 categories (i.e. conditions, directive decisions, insufficient consideration of customer, project planning, project management, change management, top management attitude, customer-contractual relationship, technology, and unexpected events) and 8 dimensions (i.e. time, cost, quality, process efficiency, satisfaction with the process, strategic goals, end-user needs, and satisfaction with product).

Most failure factors identified in the Pankratz and Basten paper are because of human factors, and although these factors potentially can be represented in the norm structures, the mechanism of human reasoning, and the inclusion of emotion, motivation, morals, etc. is not considered to any level in artefact 5. Accordingly, this needs to be highlighted and critically considered in a future artefact (see artefacts 7, 8, and 9).

5.7. Conclusion

This chapter has considered four iterations of the design science research methodology, as suggested by Vaishnavi and Kuechler (2004). Each iteration has considered a separate problem that needed to be addressed in the creation of a holistic Information Systems model, and each artefact introduces a relevant solution. Although many issues have effectively been addressed the outcome artefact has not yet reached satisfaction, since issues concerning interaction complexity, use behaviour, Habit, and Hedonic motivation need to be improved. As such I return to circumscription via the evaluation stage (see figure 3.5). In chapter 6 these issues will be considered in turn.

Chapter 6
Artefacts 6 to 9

6.1. Introduction

In this chapter I aim to adapt the DSR artefact, through artefacts 6 to 9, in order to consider in more detail, the need to reduce interaction complexity, and represent use behaviour, Habit, Hedonic motivation, and other human factors. By considering each of these points, I aim to achieve a 'satisfising' artefact solution.

6.2. Artefact 6 – Consideration of the IPO model

6.2.1. Awareness of the Problem

One issue raised in the DRS evaluation, see section 5.6, relates to the high level of complexity that could occur when considering interaction between systems: particularly in artefacts 2 to 5. Currently direct interaction occurs at all norm points, which are now connected (unlike artefact 1) to external influence. Although this direct connection supports direct interaction, i) systems normally have clear channels through which interaction occurs, and ii) a non-managed form of interaction adds a level of complexity to the model that chapter 4 results suggested students may find confusing. In section 6.2, I will consider whether the IPO model could be used to reduce and/or manage input complexity.

6.2.2. Suggestion / Development

The Input-Process-Output (IPO) model is widely used in the domain of system analysis and software engineering (see section 2.1) to simply describe the informational flow that occurs within and between systems. Information is i) acquired from the environment, through the system boundary via input devices, ii) transformed within the system to add value and complexity to the system output, and iii) disseminated from the system to those that benefit from the added value.

Since technical systems, such as a computer, acquire information from network interface cards (NIC), the keyboard, the mouse, the camera, etc.; and a whole array of additional input channels that can be considered inputs. Such information requires, however, that the flow of information is captured and processed, so system can effectively use the inputs to trigger processes, resulting in the creation of value outputs.

In humans, perception of the world is shaped by our capture, and interpretation of data from our multi-sensorial channels (Ghinea, Timmerer, Lin, and Gulliver, 2014). Perception can be considered as unconscious bottom-up assimilation of information from multiple senses (Goldstein, 2013), which are combined, aligned, distributed, and/or compared against a set of higher-order cognitive schema – i.e., representing the world model as we have understood it to be (Mayer et al., 2003).

The input is subsequently transformed (i.e., processed) and disseminated (i.e. output); often requiring the changing of form, the combining of information sources, and/or the inclusion of additional resource/energy, into a form that supports the creation of perceived value. Value by nature is contextual, however a system is useful if the processed output has greater worth than the sum of its component parts. A company that is not able to add value to its customers will soon go out of business, and any technical solution that does not add efficiency, effectiveness, or customer satisfaction needs to be critically reviewed to determine whether it is fit for purpose. To facilitate consideration of this perceptual barrier, and to support application of the IPO model, we propose inclusion of a I/P/O wrapper around artefact 5 (see figure 6.1). Instead of directly assimilating technical, formal, informal norms from the world – as though norms were simply floating about in the world ready to be captured – we have added a perception layer within which norms are decomposed from memes, and/or formed based on observation. The perception layer therefore acts to shape norms from reality and distribute them to relevant norm structures. Technical norms can be created within the system to represent how things are done in the world. Formal norms can be created by the system to represent the structured rules and constructs that describe the world. Informal norms can be created to represent identified intentions and dreams. And Conceptual norms can be created to structure goals and system purpose.

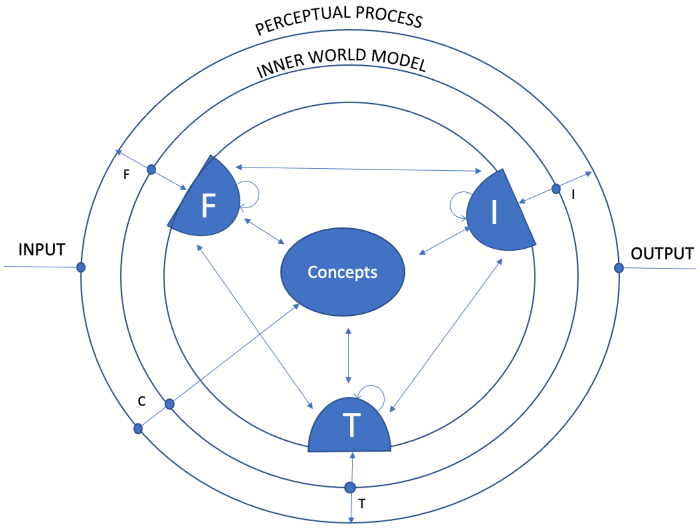


Figure 6.1 – Artefact 6: Inclusion of an I/P/O rapper around the flux model.

Inclusion of an I/P/O rapper allows educators to more systematically discuss the ideas that systems need to interpret the real world via a perception horizon, and that each system will assimilate a different view of the world, based on the context considered and/or the perception point. Businesses are only aware of customer needs and business trends etc. if i) this information is available to them via an input, and ii) this information is effectively assimilated and processing within the system. Similarly, humans construct an understanding of the world in which they live, consciously or unconsciously, by interpreting what they see, hear, smell, touch, and taste; and comparing this against our existing model of the world. If, the real-world response to an output does not match our model norms, then either the input data is wrong, or processes are wrong. By simply adoption of the IPO model as a wrapper (see figure 6.1) the educator can apply the model to several areas without having system interaction and complexity become overly complex.

6.2.3. Critical Evaluation

To addition of an IPO wrapper is a simple step, however it significantly reduces the level of complexity in the interaction between different systems. Instead of having parallel interaction, at all norm points, interaction in the IPO model is now managed through a single input and perception layer. This single path not only allows a simplifying of the interaction between systems but gives educators the opportunity to discuss the implications that input channel and perception has on ability of an individual to undertake effective processes. Moreover, it further pushes the point that a system's world model may be significantly affected by perceptual ability, information assimilation, and interpretation.

6.3. Artefact 7 – Explicit consideration of Behaviour and Reaction

6.3.1. Awareness of the Problem

Several points raised in the first DRS evaluation (see section 5.6) related to the need to consider, explain and incorporate behaviour and thinking in the artefact model. To describe use behaviour, which is the key output of the UTAUT2 model, we need to have an explicit consideration of behaviour. Moreover, consideration of Habit highlighted that a distinction needs to be made between thought, learning, and behaviour (both unconscious reaction, automatic reactions and behaviour, and logical reasoning). Within section 6.3 I aim to adapt the artefact 6 model by i) adding an explicit behaviour layer to the artefact model and ii) add relevant links between a) perception process layer, b) the system behaviour layer, c) the inner world model, and d) the norm structure, which manages norm reasoning (using the adapted 3d-RAB model), i.e., to represent different forms of thinking and behaviour that have been identified in literature; and/or support teaching of information systems.

6.3.2. Suggestion / Development.

Firstly, to support the explicit consideration of behaviour, and make a distinction between input (perception) and output (behaviour) I propose the addition of a behaviour layer between the perceptual process layer – which is the outer layer of the system – and the inner world model (see figure 6.9). The input (from the IPO model) feeds the perception process layer, and the behaviour layer feeds the system output (in the IPO model). The interaction between the four layers (i.e., perception, behaviour, inner world model, and reasoning) relates to the processes that exist in the system (see figure 6.2).

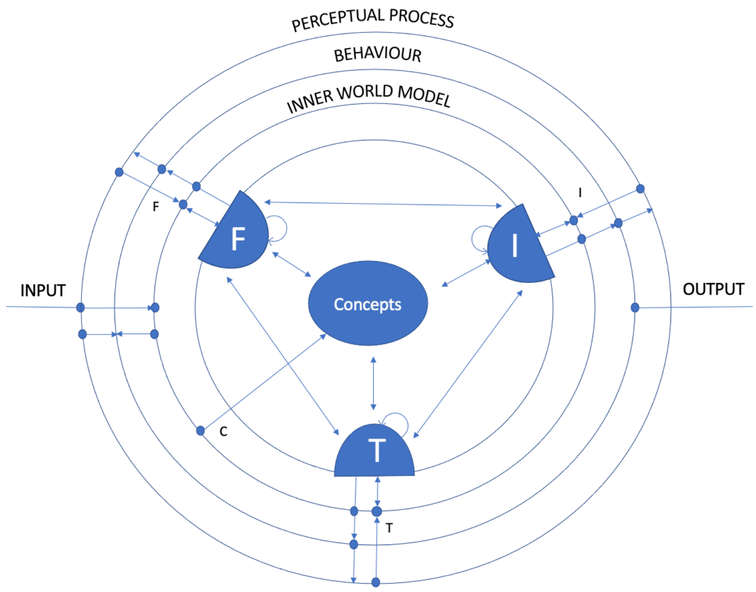


Figure 6.2. Artefact 7 - Added behaviour layer and interaction description.

Before we consider behaviour in any detail it is important to make a distinction between i) automatic physical and ii) behavioural reactions. An automatic physical reaction is a stimulus-response that is not learnt and does not consider the context of the response (Robbins et al., 2017). Such responses are physically defined and are like all systems of the same type irrespective of background and learning. Such physical responses – such as automatically pulling your hand away from a painful heat source and/or muscle responses – are unconscious and physically automatic. Automatic behavioural responses are processed unconsciously or subconsciously, however the response that occurs is often learnt.

Unconscious Reactions

Most systems contain automatic reactions that respond in case of specific received inputs. The ability to undertake automatic reactions allows a system to maintain low level, but critical, functions that would otherwise swamp the mind if processed consciously. For example - in the case of humans, numerous automatic responses exist to respond to occurrences such as cold weather (such as shivering and goose-bumps), hot weather (such as sweating), or flight or fight responses (such as increases in chemicals such as adrenaline and cortisol). Automatic responses to stimuli is critical to system functionality. For example, recently my father was diagnosed with a reduced ability to produce cortisol. Cortisol, the primary stress hormone, increases sugars (glucose) in the bloodstream, and enhances someone's ability to manage glucose use.

Accordingly, Cortisol is critical in the human fight-or-flight response. The inability of my father's body to provide enough cortisol, resulted in his inability to make stressful decisions, and resulted in him experiencing increased levels of fatigue and weakness. The ability of the system, to automatically respond to certain inputs is critical.

A bank, for example, does not manually examine every transaction that you purchased on your credit card, however you expect unusual credit card activity to be highlighted as possible fraud. Surely it is better the credit card company automatically processes all transactions, and questions unusual transactions, i.e., because an activity 'looks non-typical' against a trained model of your transaction history, than the bank resigns itself themselves to leaving transactions unchecked. Increasingly businesses are using AI, and automated interaction methods (for example chat-bots), to respond automatically where possible. An effectively trained system can identify patterns of typical and nontypical behaviour, allowing the business to focus human cognitive energy on problem transactions that need human focus.

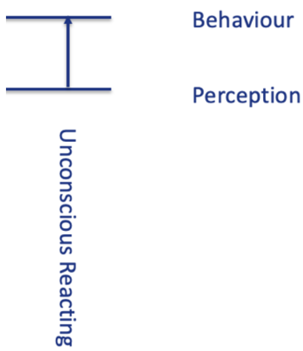


Figure 6.3. A direct link needs to exist between perception and behaviour.

As such a direct link needs to exist between perception and behaviour (see figure 6.3). This link allows the system to automatically predefine a reaction in behaviour that triggers automatically, i.e., without the need to involve either the 'inner world model' or critical reasoning. For example, Ray Dalio, the founder of Bridgewater Associates and author of the book 'Principles' (Dalio, 2017), developed an automated trading system that bought and sold share stock using pre-defined rule – i.e., 'principles'. These rules were developed, based on analysis of numerous dimensions of trading data, to activate trades without the involvement of illogical and irrational humans. Since these rules were defined over time, because of statistical analysis of data taken from experiences across the company (not just the experiences of a specific individual), they act as an automatic trigger for behaviour that bi-passes individual critical decision making.

Since the rules were effectively defined, and constantly updated, this allows the trading system to buy potential ‘growth stock’, and dump ‘falling stock’, very quickly, i.e., before the conscious market responds - maximising profit and minimising the impact of significant loss. In the case of fight or flight, such automatic behaviour can mean the difference between system life and death. An ability to respond automatically can also significantly reduce the quantity of information being consciously processed.

On a personal note, thanks to effective medication my father is now much recovered. His inability to do anything throughout his illness, however, highlighted significantly how much automated systems are critical to the function and survival of the system as a whole.

Observing

Automated responses require genetic adaptation. Although automatic responses are fast, the world in which humans live is far too complicated, and is changing far too quickly, to support all decision making genetically. Geneticists, looking at virus mutations, suggest that a positive mutation can take between 250 and 20,000 generation to become a majority trait (Lenski, 2017). This might be fine in short living viruses but is not viable as a solution to human adaptation and decision making. In his book ‘how to argue with a racist’ the geneticists Adam Rutherford critically discusses weather DNA is truly responsible for the significant differences that lie at the heart of the stereotypes and biases that many hold concerning different people types and groups. As well as being an excellent read, Rutherford concluded that, although DNA does have an influence over time, individuals who excel at specific skills are normally statistical outliers. Certain groups of people may seem to excel at specific traits, e.g., individuals with Jewish descent appear to have a higher average IQ, which maybe explains why 22% of all Nobel prizes have been acquired by Jewish individuals; individuals of west African descent are stronger and faster than white Europeans, which might explain why no white man has been in the 100 Olympic final since 1980; people of east African descent are excellent at endurance events, which might be why the Male London Marathon race has been won by a Kenyan or Ethiopian each year since 2002. Rutherford argues, however, that this is not (at population level) always due to genetics, but because of cultural norms that support the creation of, and excelling at, certain skills.

Piaget’s unified constructivist and structural views of learning suggests that individuals learn about the world from those around them (see 2.4.5). If individuals are surrounded by excellence thinking and/or behaviour, then excellence becomes the norm. It's therefore critical that not only should these individuals be physically supported (as implied in Maslow's hierarchy of needs), but that effective observation is supported to allow new systems to learn from, and adapt from, existing excellence. For example, in the 1976 Olympic Games, the United Kingdom – with 242 athletes - won 13 medals (including 3 gold medals). These gold medals we're in the areas of swimming, sailing, and modern pentathlon. In the 2012 Olympic Games, the United Kingdom - with 541 athletes – won 65 medals (with 29 gold medals). In the area of swimming, we won several silver and bronze medals. In sailing we won one gold medal and four silvers. In modern pentathlon we won one silver medal. In these three activities TeamGB performed very similarly the 1976 levels of excellence. In other disciplines, however, TeamGB athletes increased significantly - particularly in cycling, rowing, athletics, boxing, equestrian, and canoeing. Clearly the genetic makeup of the United Kingdom did change minutely between 1976 and 2012, and some might argue that some sports (such as boxing and athletics), resulted in increased success, due to greater UK genetic diversity (e.g., Mo Farah winning 2 gold medals in long distance, or Anthony Joshua winning the Super heavyweight gold). Such racist thinking, however, fails to explain the success of athletes such as Luke Campbell (who won a gold in the bantamweight boxing) or Greg Rutherford (who won a gold in long jump).

After the UK finished 36th in the Atlanta games, the national lottery and UKsport invested a huge investment in key sport categories, where tiny margins make the difference between no medal and gold. Due to UK Sport investing huge sums (264 million before London, 274 million before Rio, and 345 million before Tokyo) in the grass roots culture of sport in the UK, and/or in the development of cultures of sporting excellence, the UK has been able to achieve over 100 gold medals in the last 25 years.

Memes of culture are all around us. To assimilate these memes, it is essential that the system observes what is perceived to be true. As such it's critical that a direct connection is added between the perception layer and the 'inner world model' (see figure 6.4). This allows the system to learn from the real-world space. As reality is observed, an extensive set of real-world model norms is constructed – e.g., existence of objects, and object attributes, object functions, and attribute values that supports the system moving successfully towards completion of its goals.

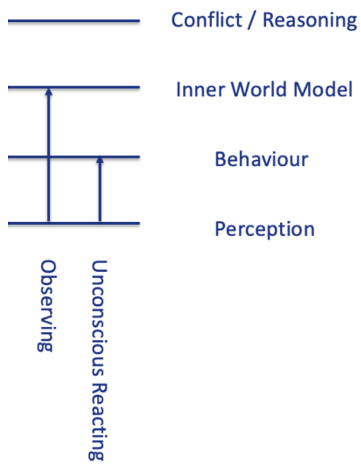


Figure 6.4. Observation requires a link between perception and 'Inner World Model'.

Automatic Behaviour Responses

In his book 'the righteous mind' psychologist Jonathan Haidt (2012) describes how thought and thinking is similar to a human rider (i.e., logical thought) sitting on the back of an elephant (i.e., intuition and emotions). Haidt argues that the rational and logical self might be able to identify the best path and may believe that he/she is in control of the intuition and emotions, however, it is the elephant that ultimately undertakes the journey, and the rider is unable to do anything if the elephant (intuition and emotions) fails to react as expected.

Such metaphor aligns well with Steve Peter's 'Chimp Paradox' (Peter, 2014) - see figure 6.5. The chimp paradox (2014) is grounded on literature that defines the human brain as being constructed from multiple systems: i) the computer system (i.e., the parietal lobe), ii) the chimp system (i.e., the limbic system), and iii) the human system (i.e., controlled by the frontal cortex). Systems are activated in order chimp / human, which assumes that the logical mind is only engaged if the chimp is unable to develop an appropriate plan (from considering previous experiences), or restrictions to the plan are in place.

The parietal lobe contains a model of the world; and stores, beliefs, memories, and experiences learnt from past experiences. In our model this is represented in the 'Inner world model'. The parietal lobe does not logically process anything; however, it can trigger automatic behavioural responses if the context is right. Such automatic behavioural responses include habits, intuition, and/or cognitive heuristics.

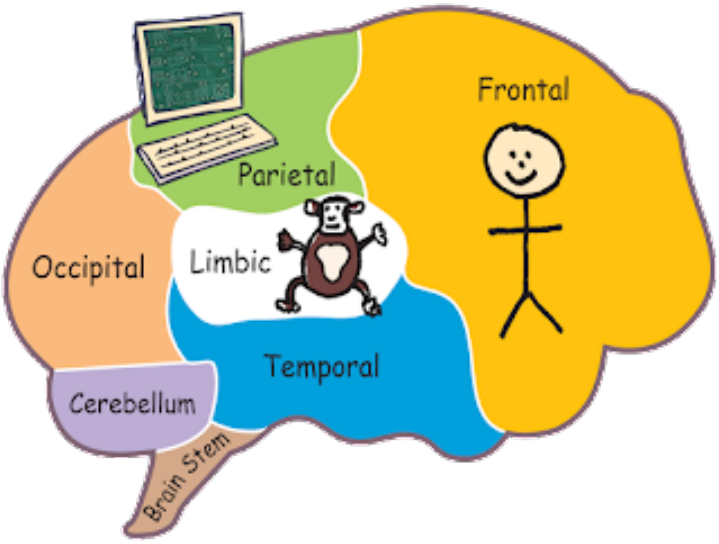


Figure 6.5. A visual representation of the mapping of the computer system, the human system, and the chimp system within the human mind (Peters, 2013).

Although virtually everyone has their own concept of the term habits, dictionaries however suggest that habits are 'settled, regularly applied automatic responses to known system inputs'. Habits are learnt behaviour, i.e., at a national, organisational, or individual level, and they are hard to change. Habits, if consciously considered, often appear illogical, sub-optimal, risky, or even dangerous (such as smoking), but a habit is often learnt from culture as the appropriate behaviour to apply in a specific context. As such, following a habit requires limited cognitive processing. Since cognitive processing is expensive (and slow), but useful to have available in case an unknown problem occurs, pre-defined habits and heuristics are usually followed (Khaneman, 2011).

If habits are followed and are 'effective enough' at providing a solution to the current problem, then this frees up higher level cognitive processing which can be used elsewhere. Wood et al. (2002) suggested that 43% of human behaviour occurs because of habit. Accordingly, it is essential to consider within out holistic information systems model.

Intuition is an instinctive feeling/understanding that occurs without any logical or conscious reasoning, i.e., a feeling that something is just good or right (Epstien, 2010). Such feelings are potentially because of previous experience where a similar situation resulted in a positive and/or negative outcome or circumstance. In such cases the solution proposed by the mind is not consciously derived but retrieved (at speed) from the 'inner world model' by drawing on what worked best in a previous situation – similar in nature to case base reasoning (Watson and Marir, 1994). As a result of experience, and repetitive action, the system develops a strong appreciation of content, i.e., what work best – however the 'why' is missing!

Heuristics, or heuristic techniques, relates to any problem-solving method that is used by a system, yet is not logically justified. Heuristics are not guaranteed to provide the optimal solutions, yet often provide 'near optimal solutions' to complex problems. Humans, for example, have developed a range of heuristics, for problems where the gains of finding a perfect answer does not justify the investment of time and energy. In 2018 I co-wrote a paper that investigated human behaviour when solving the travelling salesperson problem (Kyritsis, Gulliver, Feredoes, and Din, 2018). The Travelling Salesperson Problem (TSP) describes the increasingly significant situation – particularly in logistics - of a delivery driver who wishes to determine the minimum distance required to travel to visit multiple locations once before returning to a base location. Identifying the minimum 'optimal' route can result in considerable savings in time and resource, however this type of problem is called a nondeterministic polynomial (NP) hard problem, where the number of possible route solutions is the factorial number of locations, i.e., ((n-1)!)/2 where n represents the number of locations. A nine location Euclidean Travelling Salesperson (ETSP) graph (see figure 6.6) has 20160 possible solutions. A ten location ETSP graph has 181,440 possible solutions. An eleven location ETSP graph has 1,814,400 possible solutions, etc. This exponential growth in the number of possible solutions makes it practically impossible to identify the optimal solution using exhaustive processing. Kyritsis et al. showed that, when presented with a Euclidean Travelling Salesperson Problem (ETSP) graph, humans use visual search heuristics to identify a 'near optimal' solution almost effortlessly - despite the billions of potential solutions available due to the number of locations (i.e., n) being unmanageably high.

By modelling human heuristics, Kyritsis et al. were able to determine a 'near optimal' solution to the travelling salesman problem i) more quickly, and ii) using limited computational resources, than existing solution heuristics (e.g., nearest neighbour, nearest insertion, farthest insertion, and cheapest insertion).

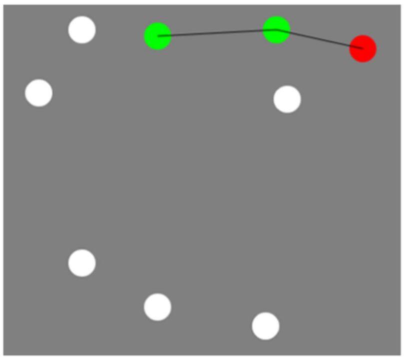


Figure 6.6. A nine location Euclidean Travelling Salesperson (ETSP) graph (adapted from Kyritsis et al., 2018).

Automatic physical responses need to be included within the unified system model, i.e., to add a mechanism that allows subconscious reaction to input stimuli because of learning that exist within the inner world model (see figure 6.7). Accordingly, a link between the ‘Inner world model’ layer and the behavioural layer was added to represent when learnt habit / intuition / heuristic norms, are triggered automatically when the norm condition, defined in the inner world model, is met.

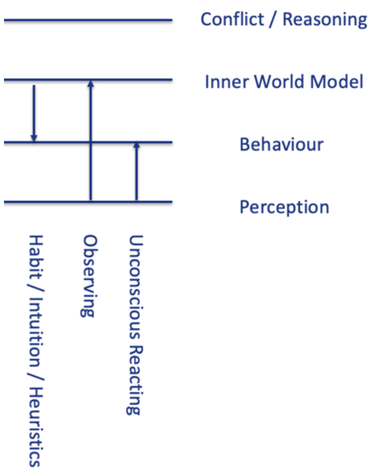


Figure 6.7. Inclusion of Habit / Intuition / Heuristics.

Logical Reasoning

In our model reasoning is consider via inclusion of two component parts: i) assimilation, and ii) reconstruction. Assimilation is an extension of observation, i.e., where perception of reality results in a change within the inner world model, which in turn results in a conflict of ‘inner world model’ norms. If multiple norms in the inner world model are in conflict, then it's critically important that some reasoning occurs to identify which norms (conceptual / informal / formal / technical) should be used and which will be rejected. As such the assimilation process allowance assimilation of new ideas and concepts that are introduced to the inner world model to be reasoned, and alignment of norms to occur.

To support this, the assimilation part of reasoning includes a trigger link between the ‘inner world model’ layer and the conflict/reasoning layer – see figure 6.8. Using the adapted 3DRAB model, as described in iteration 5, the system can identify the best current norms to support current system goals. Once the most effective norm is identified, then the in a world model needs to be updated accordingly.

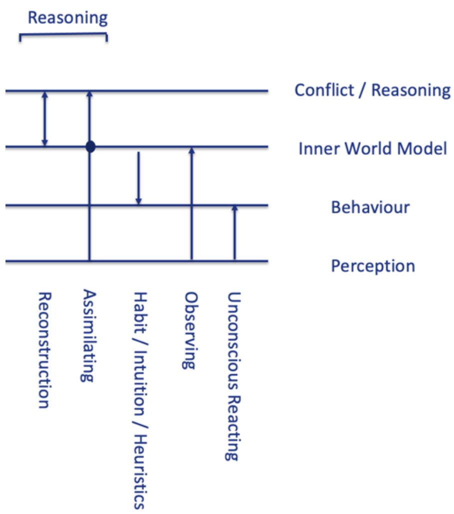


Figure 6.8. Inclusion of Reasoning – Assimilation and reconstruction links.

Iterative reconstruction of the ‘inner world model’ occurs when changes occur because of flux caused by norm reconstruction. Changes in the believability of norms, or the changing of current norms, may result in new norm conflicts. As such an additional bidirectional ‘reconstruction’ link is required to facilitate (if possible) the iterative reshaping of the inner world model. The aim of reconstruction is to minimise, where possible, the cognitive dissonance that exists within the system due to conflict between Norms. The removal of dissonance, however, may not be possible, and the final set of norms (the state of least dissonance) may be far from a fully stable state. Additional observation, or personal reflection (as will be discussed below as part of the confirmation stage), plus a return to the reconstruction reasoning stage, may be required before cognitive dissonance can be removed – though there are no promises that a non-conflict state can ever be achieved (though flow, as described by

Csikszentmihalyi (1990), implies that a low conflict balance between reasoning and confirmation can be reached for short periods of time).

Confirming

The confirming stage also includes two stages: i) reacting, and ii) reflecting. The first stage of confirming relates to reaction – that triggering changes in object attribute values or relationships. Reacting is the outcome of logical reasoning on behaviour; and therefore, requires the formation of a link between the conflict reasoning layer and behaviour. The act of logically and consciously 'reacting' to event is synonymous with slow thinking described in Daniel Kahneman's Dual processing model (Kahneman, 2011). The second stage of confirming relates to reflection. Reflection occurs when the system perceives its own behaviour, and the response to that behaviour that occurs within the real world. If a particular object attribute is manipulated by the existence of the behaviour, then reflection is the observation of the response that occurs as a result of this manipulation in the real world; thus, updating of the 'inner world model' (via observation). Reflection can be used to assess the impact of any behavioural change; including reactive and automatic behavioural changes, although change of reactive or automatic behaviour is hard. The inclusion of reflection within the model allows us to identify contexts where we consciously identify that our automatic responses can have a negative impact. In business, this allows us to identify when reactive responses, have a negative impact – allowing the business analyst a more holistic understanding of the reaction and interaction of different object variables. Identification and appreciation of illogical behaviour or 'unhelpful ways of thinking', is core to cognitive behavioural therapy (CBT); and does suggest that reflection is key (over time and with reinforcement) to improvement of system automatic behavioural responses.

To include the idea of reflection we propose the addition of two links: i) one between the behavioural lay and the perception level, and ii) the second link between the perception layer and the 'inner world model' layer (see figure 6.9).

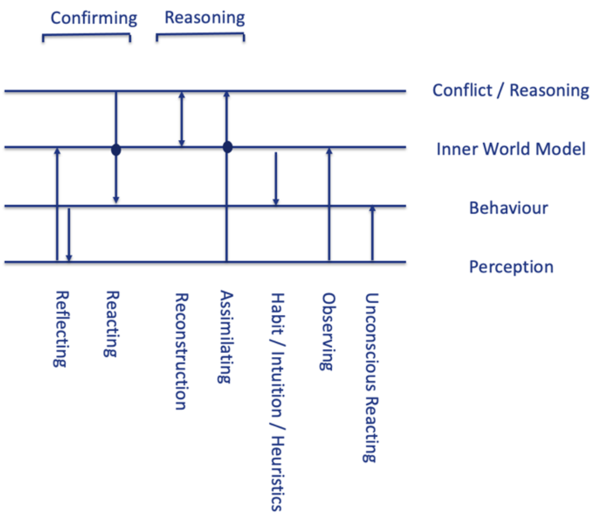


Figure 6.9. Addition of confirming (Reacting and Reflecting) interactions.

6.3.3. Critical Evaluation

In artefact 7 I aimed to i) add an explicit behaviour layer to the artefact model, and ii) add relevant links between a) perception process layer, b) the system behaviour layer, c) the inner world model, and d) the reasoning layer, i.e., to represent different forms of thinking and behaviour that have been identified in literature; and/or support teaching of information systems.

By considering the interaction of four explicit layers (i.e., perception, behaviour, inner world model, and reasoning), I was able to justify, considering relevant literature, the need for consideration, and inclusion of, unconscious reactions, observation, habit / intuition / heuristics, the act of reasoning (composed of assimilation and reconstruction links), and the act of confirming (composed of reacting and reflecting links) – see figure 6.9.

Inclusion of these behaviour and thinking mechanisms allows the educator to discuss, with significant detail, how a system might systematically create norms and therefore shape the inner world model, assimilating information from the perception layer, and how logical reasoning manages the reconstruction of the model when expected outcome do not match reality.

The proposed links and connections are obviously an oversimplified model of reality, yet are sufficient to support consideration of habit, bias, management decision making issues, and learning.

6.4. Artefact 8 – Considering Emotion

6.4.1. Awareness of the Problem

The need to consider emotion was highlighted during to first DSR evaluation, which demonstrated that artefact 5 was unable to represent hedonic motivation, and consider many failure factors (identified in Pankratz and Basten) due to existence of emotions; e.g. ‘Stakeholders responsible for project not open for problems / criticism’ due to unspoken fear of failure.

Emotions may be seen by many as subjective, and unimportant to systems thing, however i) emotions have been shown to play a central role in the evolution of consciousness, ii) influence the emergence of higher levels of awareness, and iii) largely determine the focus of consciousness; with emotions and feelings constituting the primary motivational component of mental operations and overt behaviour (Izard, 2009). Emotions can help a system in response formation and has been found to play a critical role in development of adaptive responses to immediate challenges to survival or well-being. Accordingly in artefact 8, i.e., in section 6.4, I will consider several emotional models and suggest a solution for inclusion in the artefact.

6.4.2. Suggestion / Development

One of the key problems in defining a structure to both capture and represent emotions is the issue of discrete interpretation. Eckman (1992), concluded that all emotions could be defined by representing six basic emotional states, which are anger disgust, fear, happiness, sadness, and surprise (see figure 6.10).

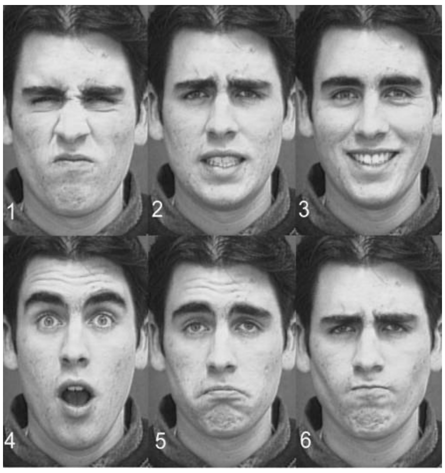


Figure 6.10. Eckman’s basic emotions, i.e., 1) disgust, 2) fear, 3) joy, 4) surprise, 5) sadness, and 6) anger (adapted from Cohn, 2006)

Human emotion is subjective, yet humans appreciate and identify distinct emotions that exist. These basic emotional states then trigger in the biological and mental states of the individual. The viewer is therefore able to distinguish emotions being able to tell how the individual is responding to their environment. By reading this emotion they can interact with that individual in a more contextually relevant way. The constructivist perspective is that a person feels responses due to physical and biological triggers, which are incidents significantly by the context in which the emotion is felt.

Although Eckman’s basic emotional set are the most widely used alternatives have been defined. Several models have been created to represent the emotional state of the individual with most models considering the level of arousal and impact that occurs during the situation. Most emotional models of emotion suggest a complex interconnected interplay between neuro-psychological systems, physical systems, and effective contexts state when the emotion is felt. Although several models have been created there only a few that have remained dominant within the field. I will now critically consider a number of these model as a possible mechanism for inclusion of emotions in artefact 8.

The Circumflex model

The circumflex model of emotion was developed by James Russell (1980). Russell proposed the use of two-dimensional space to represent arousal (i.e., a state of physiological activity) and valence (level of pleasantness feeling) dimensions - see figure 6.11. In the circumflex model the emotional state of the individual can be represented on a scale from neutral too active. The circumflex model is often used to identify the existence of emotional arousal within experiments; however, the specific emotions being considered must be predefined to support useful and effective application.

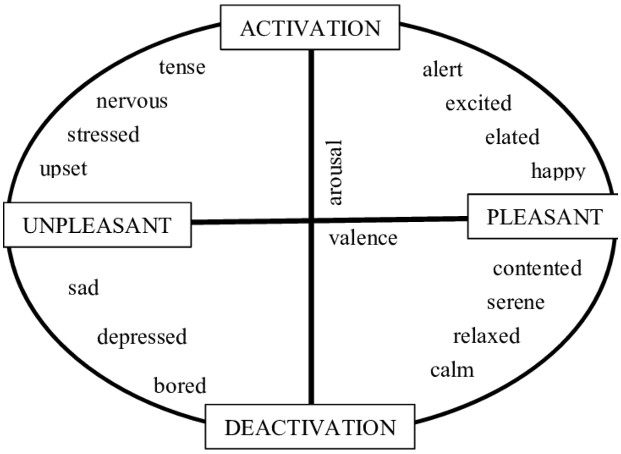


Figure 6.11. Circumflex model (adapted from Russell, 1980).

Although the circumflex model allows definition of activation and pleasantness, the mapping to Ekman's basic emotions is unclear as it is not clear how emotion maps to level of activation, i.e., since a physical response to such emotions is often culturally defined.

The Pana Model

The Pana model, developed by Watson and Tellegen (1980), proposed that level of activation (low and high) and level of positivity (low and high) can be used determine distinct emotional types. The Pana model is similar to the circumflex model, however the panna model mapping is clearer (see table 6.1)

Table 6.1. Pana model states.

Activation	**Positivity**	**Emotion**
High	Positive	Excited or Surprised
High	Negative	Hostile
Low	Positive	Calm
Low	Negative	Dull

Between hostile and excited states is arousal. Between excited and calm states is happiness. Between calm and dull states there is quietness. And between dull and hostile states there is sadness. Although the PANA model emotional mappings are clearer, the PANA model can practically only represent a small number of emotions, which is not ideal within a holist information systems model.

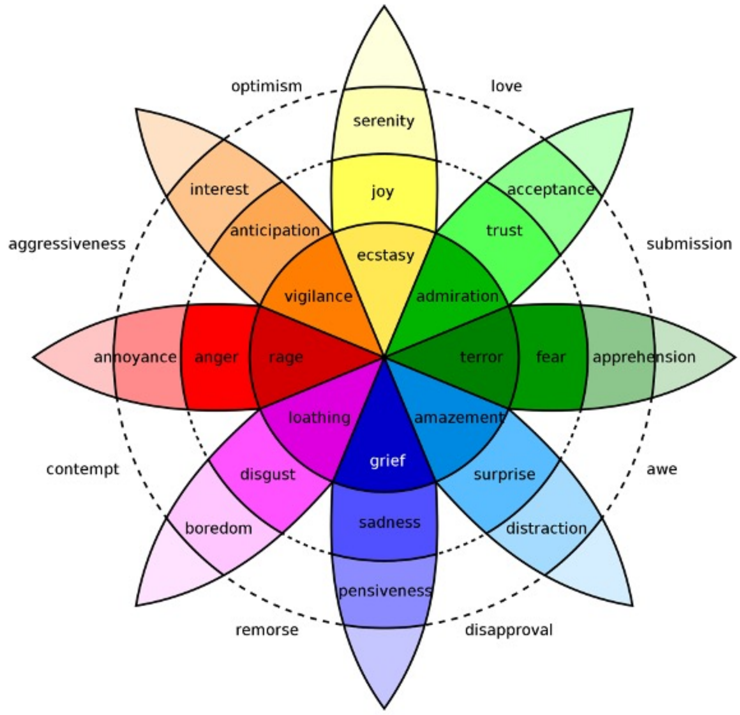


Figure 6.12. Plutchik's Emotional model (adapted from Plutchik, 2002).

Plutchik's Emotional Model

In 1980 Robert Plutchik (1980) defined a model of emotion that consisted of eight emotional categories – i.e., joy, trust, fear, surprise, sadness disgust, anger, and anticipation - which covers all Eckman's emotions. Plutchik's emotional model also identifies i) interaction of these eight dimensions, and ii) the strength with the which that emotion occurs. Emotions are presented using three concentric circles (see figure 6.12) where the inner circle is more strongly felt, and the outer circles are less impactful – accordingly an emotion has a type and a level. Level of emotional intensity helps to guide our understanding of the intensity of the motion. For example, rage at a lessor intensity might be perceived as respectively anger or mild annoyance. Rage, anger, and annoyance are all linked depending on the intensity of the emotion. If multiple similar emotions exist at the same time, e.g., amazement and terror, then the results outcome would be a mixed feeling of awe – which sits between these emotions (see figure 6.12).

Plutchik's wheel of Emotion

Plutchik's wheel of Emotion was developed as an extension to Plutchik's emotional model. The model considered the same eight emotions (i.e., joy, trust, fear, surprise, sadness, discuss, anger, and anticipation), yet Plutchik linked neighbouring emotions (which he termed a dyad – being composed of two parts). Primary dyads (i.e., love, submission, awe, disapproval, remorse, contempt, aggressiveness, optimism) represent the combining of emotions that sit next to each other, i.e., direct neighbours on in the wheel. These primary dyads are the same as those considered in Plutchik's Emotional model. Secondary dyads (i.e., hope, guilt, curiosity, despair, unbelief, envy, cynicism, pride) represent the combining of emotions that are two emotion steps from each other (see figure 6.13). Tertiary dyads (i.e., dominance, anxiety, delight, sentimentality, shame, outrage, pessimism, morbidness) represent the combining of emotions that are three emotion steps from each other (see figure 6.13). Although the wheel only captures maximum of eight emotional measurements, the use of primary, secondary, and tertiary dyads, and consideration of emotional intensity, allows the model to quantify up to 48 different emotions. This ability, i.e., that Plutchik's wheel of emotion captures simplicity, yet is able to represent complexity aligns well with the needs of a holistic information system model, and as such will be selected for implementation within our model.

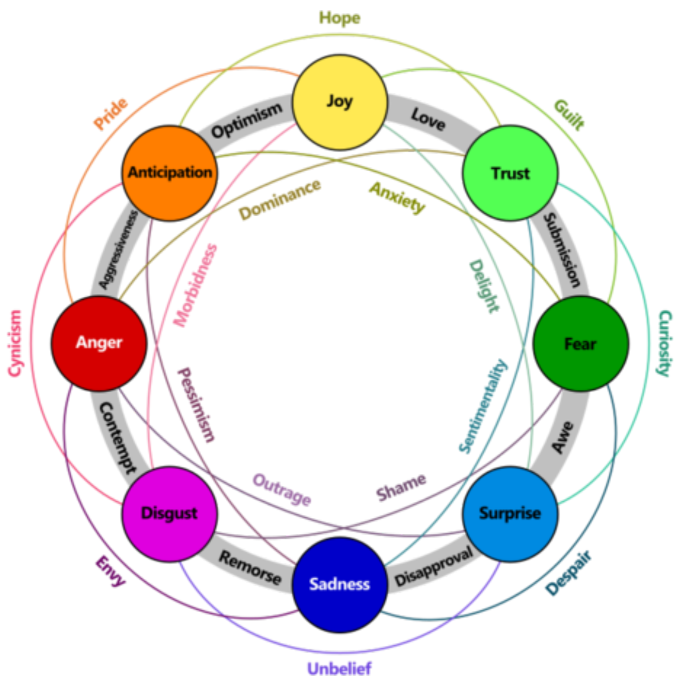


Figure 6.13. Plutchik's wheel of emotion - Interaction of emotions demonstrating primary, secondary, and tertiary dyads.

Plutchik's wheel of emotions has been used widely to understand emotions, sentiment, and intensity analysis within written text (Abbasi and Beltiukov, 2019; Beltrán, et al. 2019), and has been incorporated in automatic analysis of social media (Tromp and Pechenizkiy, 2014). Within our model we propose linking norms (as required) to emotional metadata, measuring emotional intensity on a scale (e.g., 0 to 1). Not all emotions will be present for each norm or may only be present in very low levels. Accordingly, we proposed collecting data about max two or three emotions for each norm.

If the emotion is felt strongly, e.g., a value of .7 to 1, then the core emotions can be stated as being rage, vigilance, ecstasy, admiration, terror, amazement, grief, and loathing. If the emotion is felt at a medium level, e.g., a value of .4 to 0.6, then Plutchiks Wheel of emotion suggests naming the emotions respectively anger, anticipation, joy, trust, fear, surprise, sadness, and disgust. If the emotion is felt at the mild level, e.g., a value of 0.1 to 0.3, then Plutchiks Wheel of emotion suggests naming the emotions respectively annoyance, interest, serenity, acceptance, apprehension, distraction, pensiveness, and boredom. This ability to identify a distinction in the emotion, because of the intensity, is useful to understand the reaction to specific norms.

Moreover, combining emotions, as demonstrated in figure 6.13 and table 6.14, allows creation of more nuanced appreciation of the emotional interaction. If for example 3 emotions have been linked to one specific norm, for example Joy, Fear, and Surprise, not only can we identify the level for each of the specific emotions, but we can also identify whether a feeling of guilt and/or delight exists because of activating a specific norm.

Table 6.2. Emotional Interaction (J-Joy; T-Trust; F – Fear; S – Surprise; Sa – Sadness; D – Disgust; An – Anger; A – Anticipation).

J_T	love	J_F	guilt	J_S	delight	F_An	conflict
T_F	submission	T_S	curiosity	T_Sa	sentimentality	S_A	conflict
F_S	alarm	F_Sa	despair	F_D	shame	T_D	conflict
S_Sa	disappointment	S_D	?	S_An	outrage	J_Sa	conflict
Sa_D	remorse	Sa_An	envy	Sa_A	pessimism		
D_An	contempt	D_A	cynism	D_J	morbidness		
An_A	aggression	An_J	pride	An_T	dominance		
A_J	optimism	A_T	fatalism	A_F	anxiety		

6.4.3. Critical Evaluation

In artefact 8 I proposed linking emotional metadata, based on an adapted version of Plutchik's wheel of emotion (where relevant) to specific norms in the inner world model. Adding this metadata will not impact the norm structure but should be considered as additional augmented information about the norm. I suggest that emotion type and intensity are measured for two to three emotions (max) for each norm. By considering the intensity of the norm, and all the interaction of norms, the holistic model would be able to identify and link the norm to at least one of 48 different emotions. This emotional information would support consideration of hedonic motivation – as level of joy would be linked to norms where joy was significant – and would allow the linking of emotion to all norms, and moreover support critical consideration of how emotion impacts system outcomes.

6.5. Artefact 9 – Motivation, Morals, and Extensibility

In artefact 9, the last artefact in this thesis, I consider additional augmenting of norms with information about motivation, morals, and extensibility. Stakeholder motivations and morals are key to decision making and definition of goals (Tobler, 2008). Accordingly, to understand the shift and impact of human factors, i.e., to understand Pankratz and Basten, it is critical to understand motivation, morals, and possibly (depending on the topic being considered) a range of other factors – yet undefined. Accordingly, motivation, morals, and extensibility will be considered briefly in turn.

6.5.1. Systems Motivation

Awareness of the Problem

Motivation is the process that initiates, guides, and maintains goal-oriented behaviours. In artefacts 3 to 8 point, the artefact used concept norms (i.e., goals) to guide system activity, however understanding the motivation why a goal was created and/or allows us to model relative goal significance. In this section, the research will consider several models, to determine how motivational meta data could be linked to norms.

Suggestion / Development

There are numerous theories of human motivation, however in this report we will briefly consider four that may be of worth: 1) Maslow's hierarchy of needs; 2) ERG Theory; 3) Herzberg's dual factor theory, and 4) McClelland's acquire needs theory.

Maslow's Hierarchy of Needs was initially proposed by the American psychologist Abraham Maslow (1943), however was revised throughout his career. The hierarchy of needs structure acts as a classification system to identify whether certain activities are motived by a desire to satisfy a deficiency in basic physiological and safety needs (e.g., food, water, warmth, rest / security, safety), by psychological belonging and esteem needs (e.g., intimate relationships, friends / prestige, feeling of accomplishment), or growth needs that support self-actualisation. In early models, growth needs related generically to someone being able to fulfil their potential – including creative activities. In the later 'extended hierarchy of needs' model, however, growth needs were decomposed into cognitive needs (creativity, foresight, curiosity, and meaning), aesthetic needs (ability to appreciate the beauty within the world), self-actualisation (the desire to accomplish everything that is possible), and transcendence (a desire to make an infinite impact) – see figure 6.14. Maslow stated that motivation, within any system, is driven by the lowest order need, and that self-actuation and transcendence is only possible if lower-level needs are affectively met. Accordingly, when planning any activity, for example development of a new degree, it is fundamentally that focus is not placed on the workspace aesthetics if basic physiological and psychological needs of the student, such as welfare, is lacking. A student's creativity is less to be realised if they are constantly hungry and/or constantly worried by the cost of living.

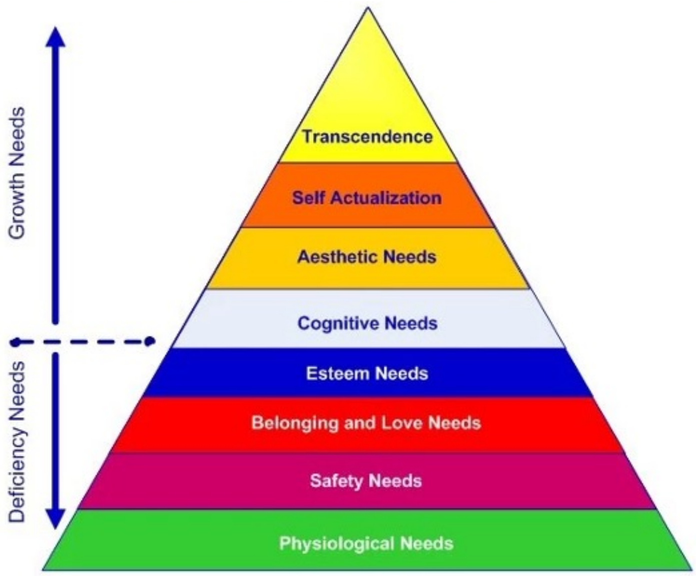


Figure 6.14. Maslow Motivation Model.

ERG (Existence / Relatedness / Growth) Theory (Alderfer, 1969) simplified Maslow's basic hierarchy of needs into three discrete categories, i.e., Existence, relatedness, and growth (see figure 6.15).

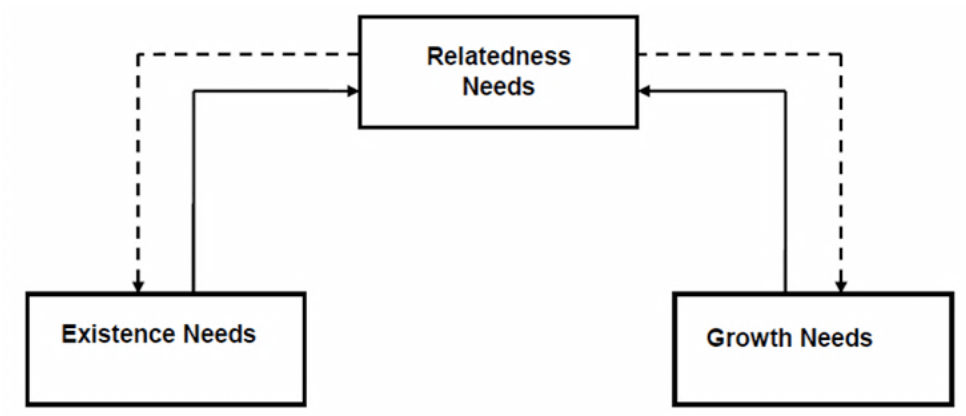


Figure 6.15. ERG (Existence / Relatedness / Growth) Theory.

Existence relates closely to Maslow's psychological and safety needs, relatedness corresponds to social needs, and great needs refer to Maslow's esteem and self-actualisation needs. One of the key differences of the ERG theory is lack of dependence. Alderfer stated that individuals would develop all areas at once, however would focus mainly on one of the three categories, until some limitation occurs. If a limitation occurs in one area (e.g., growth), maybe due to a lack of resource in another area (e.g., existence or relatedness), then the focus of motivation would switch - termed the frustration-regression hypothesis - with the aim of removing the limitation. The primary implication of this theory is that, depending on the issue, individuals may be motivated by different levels at the same time.

Herzberg's Two factor Theory (Herzberg and Mausener, 1959) considered motivation differently to that of Maslow and Alderfer. Heinsberg conducted several interviews with workers and identified that the aspects of work that satisfy workers is distinctly different from those aspects that dissatisfied them - suggesting that satisfaction and dissatisfaction were not two sides of the same coin. Herzberg label factors that cause satisfaction as 'motivator' factors (Herzberg and Mausener, 1959; Herzberg, 1965). Motivator factors control the conditions that infuse an employee to work harder within the environment, and includes recognition, the sense of achievement, opportunities of career development and growth. Factors that result in dissatisfaction were defined as 'hygiene' factors, which included company policies, working conditions, salary, supervision arrangements, safety, and security etc.

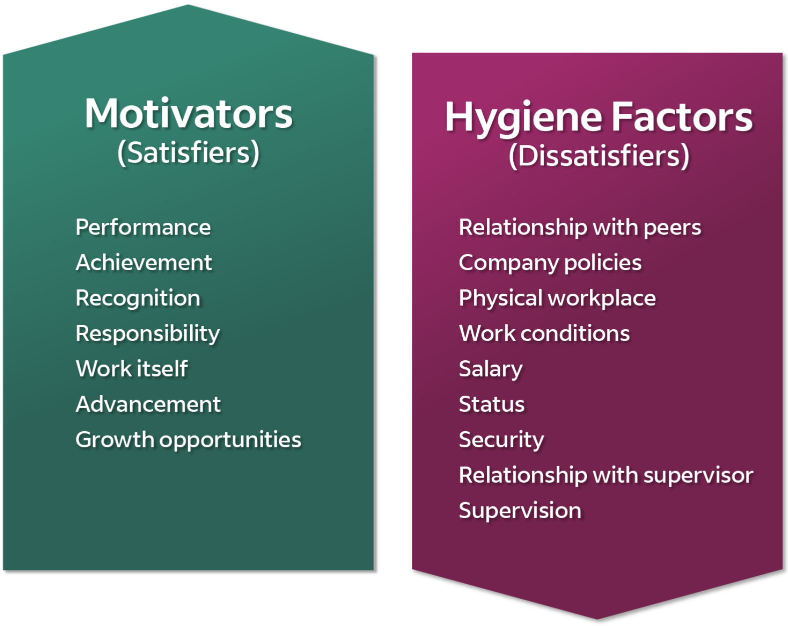


Figure 6.16. Herzberg's Two factor Theory – including Motivators and Hygiene Factors (adapted from Herzberg and Mausener, 1959).

Although the classification of satisfiers and dissatisfies has been criticised (e.g., Cummings and Elsalmi, 1968), however the two-factor theory does i) separate the concepts of satisfaction and dissatisfaction - highlighting that the fact that one is not the confirmation of the other, and ii) supports the realisation that improvement of the environment (i.e., betterment of the hygiene factors) is critical, yet it may not result in improvement in staff motivation.

McClelland's Theory of Acquired needs states that individuals acquire three types of needs because of their life experiences, i.e., achievement, need for affiliation, and need for power. Someone with a high need for achievement is driven to be successful, i.e., achieving satisfaction from meeting deadlines and/or planning and implementing concrete outcomes. Individuals with high achievement scores do well in roles that include explicit goals, and immediate feedback that give the individual with a feeling of discernible success (Certo and Certo, 2005). Due to their high drive towards success, individuals with a high level of achievement are often promoted to high end positions (McClelland & Boyatzis, 1982), yet such people i) see high level management activities (such as communication, mentoring, meeting with staff) as pointless, and ii) have trouble delegating authority, instead micromanaging, or dictating subordinates. Individuals with a high need for affiliation like to interact with others and like to be accepted by others (Wong & Csikszentmihalyi, 1991). Although emphasis on harmony implies a positive working environment, the lack of critical feedback, lack of discipline, and poor decision making can result in loose management and inefficient operation. Individuals with a high desire for power, with the primary aim of bettering their own situation, will often seek to control and dominate their environment; irrespective of the impact it has on others. Individuals with a high desire for power, who aim of achieving an altruistic outcome, will often seek to a better allocation of resources for all (Spreier, 2006). McClelland's theory of acquired needs suggests that individuals are driven by different things – i) someone with a high need for achievement is most likely to be driven by defined goals, ii) someone with a high need for affiliation may be driven by a desire to find the approval of others, iii) someone with a high need for power may be seeking personal gain or aiming to implement positive change. McClelland's theory of acquired needs, therefore, can help manager to better appreciate their natural motivation, i.e., to be more aware of possible drawbacks that exist because of their natural preference / position.

Maslow's hierarchy of needs model allows us to define whether a norm is critical to the provision of deficiency needs, i.e., it is critical to system survival, or whether the norm is useful to support the system in growth and/or development. Alderfer's ERG model supports the idea that not effort is focused on one thing due to i) a need for material provision, ii) interpersonal relationship development, and iii) personal growth, and therefore may be used to explain and/or predict workplace issues, relationship paradigms, and personal development choices (Caulton, 2012). Herzberg's two factor theory separates the concepts of satisfaction and dissatisfaction and supports the realisation that environment and motivation are not inherently linked. Finally, McClelland implies that people, and supposedly organisations, are driven by different things, i.e., achievement, affiliation, and power. Each of the models offer the holist model a different, distinct, yet useful appreciation of motivation. I therefore suggests that metadata for each approach be developed. For Maslow, I propose use of an optional tag to signify for each norm the level being considered, e.g., PN = Safety needs, AN = Aesthetic needs, etc. If a university course developer were considering the norms that construct their programme, then it would be clear that deficiencies existed if certain tags (such as PN) were not included in the inner world model of the new programme. Use of such a tagging system would also allow the developer to compare the current program norms with other outstanding programmes. ERG allows consideration of focus, which is useful to identify whether specific norms become a stumbling block within the system. Accordingly, I suggest that additional metadata concerning both i) occurrences of norm use, and ii) point of previous use, should are added to the model. If a norm is used all the time, then this norm is critical to the operation of the system. If a norm is never used, then – like turning your clothes in a closet at new year – then you would be able to identify this and remove those that are no longer of significant value to the system – possibly putting such norms into archive. Herzberg's two factor theory, like Maslow's deficiency and growth needs, allows a separation of norms, however unlike Maslow, Herzberg relates to personal preference. I personally cooks to eat – i.e., to satisfy my basic physiological needs - but some people (thankfully including my wife) cook because they enjoy doing so. We could attach an emotion to the norm, as stated in artefact 8, however the process (the work itself) brings my wife a sense of achievement. This is different from one of eight emotions discussed in artefact 8, and therefore should be added (as appropriate) using additional metadata to each norm. Finally, system stakeholders, which can be represented as objects in the inner world model, may be driven by different needs – i.e., achievement, affiliation, and power. My wife, as stated above, acquires achievement from cooking. My daughter cooks because she likes to share food with her friends. My son cooks because it means he is not dependent on food being given to him by others. The same activity is motivated differently, depending on the stakeholder focus. Accordingly, I perceive value in addition of this distinction to each norm (as required) via the additional of metadata tags.

Critical Evaluation

Due to distinction of the four models presented, I did not feel that a one-size-fits all suggestion motivation solution was appropriate. Accordingly, relevant metadata should be linked to appropriate norms, to support the appreciation of norm use and motivation linked to different stakeholders and situations. Understanding motivation is key to appreciation of the human system, which is particularly needed to be able to critically discuss information systems failure. Inclusion of all four solutions provides a significant appreciation of motivation level (Maslow), resource focus (ERG), satisfaction factors (Herzberg) and stakeholder need (MacClelland). I believe that use of multiple tags, i.e., multiple use not integration, would provide the best solutions for use in the holistic information system model.

6.5.2. Systems Morals

Awareness of the Problem

Moral reasoning supports human critical analysis, since it supports individuals in determining what is right and wrong; as well as the boundaries of system activity and focus. Since the brain uses to similar mental process to determine both i) ‘What should I eat for lunch?’ and ii) ‘Should I lie about this?’, it seems important that our holistic information system should be able to incorporate some level of moral reasoning. A lack of no moral reasoning in a system model is analogous to implying that the most logical person is a psychopath. A lack of emotion may result in a solution that may more efficient, such a soylent green, yet there is increasingly need for systems to consider the moral implications of system outputs. Moral reasoning uses logical rules (deontology) or moral theories (e.g., utilitarianism), to identify the best outcome to a specific situation. Accordingly, moral reasoning is, as is most things, learnt constructively by observing the reactions of those around us, which implies that moral judgement is both i) individual, ii) contextual, and iii) commonly driven by emotions, internal biases, and/or external pressures. Accordingly, as individuals (objects), context (norms), and emotions (metadata tags) are already contained in artefact 8, the consideration of morals appears to be of value to the holistic information system model; and would support consideration of human activity and behaviour.

Suggestion / Development

Kohlberg (1971; 1975) presented a model consisting of three levels (with each level constructed from two stages). Stages within Kohlberg’s model cannot be skipped, as high order levels are grounded on low levels; and the removal of lower levels would cause the moral structure to collapse. Levels are: Level 1 (Pre-conventional): Stage 1 – Obedience and punishment (“How can I avoid punishment?”); Stage 2 – self-interest orientation (“If it feels good, do it”); Level 2 (Conventional): Stage 3 – Interpersonal Accord and Conformity (“Do it for me.”); Stage 4 – Authority and social-order (“Do your duty!”); Level 3 (Post-Conventional) – Stage 5 – Social Contract (“This is the consensus of thoughtful men.”); Stage 6 – Universal ethical principles (“What if everyone did that?”). Some, however, have rejected Kohlberg’s model because it i) emphasises on justice above all other values, ii) assumes that moral action is because of formal reasoning (Haidt, 2001), iii) presents a largely western / male moral bias (Harkness et al., 1981), and iv) does not consider inconsistencies in moral judgments (Hetherington, Parke, and Locke, 1999). The moral foundations were introduced by Haidt and Joseph (2004), in response to the moral structure proposed by Kohlberg, i.e., to provide a solution that explains the variety and universality of moral judgement, whilst addressing some of the issues with previous solutions. The work of Jonathan Haidt is based on the assumptions that : 1) a basic moral template exists (at birth) in the human mind, suggesting that people find it easier to learn certain moral constructs, yet 2) the template is populated by, and evolves within, a specific moral culture /

context, which means that moral reactions are often learnt over time from others within the environment, 3) that emotion and intuition comes before logic moral reasoning (as discussed in artefact 7), and 4) that individuals often possess a number of potentially conflicting moral foundations that trigger as part of a person's moral response. Six moral foundations were proposed by Haidt et al. (2012), these are:

- Care/Harm – This foundation relates to the fact that all mammals inherently have innate attachment systems (particularly to our families and young), and most humans possess an ability to feel (and dislike) the pain of others - resulting in virtues such as kindness, gentleness, and the nurturing of the less physically strong.
- Fairness / Cheating - this foundation relates to the innate human virtue of reciprocal altruism, i.e., that there should be either i) justice, fairness, and equality for all (the liberal viewpoint) or ii) a fair allocation of wealth / pay proportional to the effort, ability, and/or level of involvement invested (the conservative view).
- Loyalty/Betrayal – This foundation is linked to the human trait of being able to put the group before the individual. The group, however, aims (where possible) to support and protect the rights of its individual members. Since the sum of the whole is stronger than the individual, the individual benefits from becoming part of that whole.
- Authority/Subversion – This foundation exists to reflect the existence of social hierarchy that exists within human culture, i.e., knowing your place in the social structure lets people work together better as a team.
- Sanctity/Degradation – This foundation was introduced to reflect the feelings of disgust and contamination that is critical to avoid dirt and disease that could have a negative impact both physically and/or mentally, i.e., that the body is a temple and that immoral activities can contaminate the body and mind.
- and Liberty/Oppression – This foundation relates to the resentment felt towards those that restrict the liberty of individuals or groups. Solidarity between oppressed individuals can result in creation of a group that together can liberate themselves.

Any system that includes human stakeholders will be impacted directly or indirectly because of the six moral foundations, as a stakeholder's position on each of these dimensions will impact motivation and decision making. Accordingly, the research suggests the optional addition (if appropriate) of metadata to each norm that i) links a specific norm to a stakeholder (as the stakeholder may have an ethical opinion concerning a norm that they are not directly involved in), and ii) the moral measurement, on a scale 0 and 1 between negative and positive, i.e., the two moral extremes. For example, a scale from 0 to 1, with 0 representing Harm (which is generally perceived to be negative) and 1 representing Care (which is generally perceived to be positive). If a stakeholder holder moral thought about any norm, then this can then be capture as one or several pieces of metadata, with each piece representing the existence of a specific moral foundation.

Critical Evaluation

I suggest adding metadata to capture information about links between stakeholder and norms. By capturing this information, we can potentially compare the different moral perspectives of stakeholders. Moreover, changes in the stakeholder moral landscape, for example view concerning norms linked to a specific object or attribute, can be compared over time, and could be used to highlight resistance to involvement in specific activities or processes.

6.5.3. Extensibility

Awareness of the Problem

It is clear that a holistic information system model (like the one proposed) could be applied in a range of information rich environments, i.e., where complex systems of systems interact. I appreciate, however, that subject specific models and ideas need to be incorporated. Ken Wilber, in the appendices of his book 'Integrated Psychology', provides charts that describe how his integral ideas link to numerous other models. I appreciate the need, as artefact iteration ends, to highlight the need for extensibility in the holistic model.

Suggestion / Development

Even though it goes against Hevner et al.'s seven DSR guidelines, the scope of this research does not include the production of a working prototype model. Accordingly, it is not possible to comment on how the solution ideas might be technically implemented, however I propose that extensibility is achieved, as in the cases of emotions, motivation, and morals, via the augmenting of, and linking, of norms using meta-data. For example, I was tempted to incorporate spiral dynamics (expounded by Beck and Cowan, 1996), to consider the change in focus that occurs as system evolution occurs, yet after considerable thought this was disregarded. I may, however, want to consider spiral dynamics in a classroom scenario. The addition of Spiral dynamic in the model is possible by linking norms to spiral dynamics metadata tags (e.g., Individual: A – Instinct driven; C – Power driven; E - Success driven; G – Process orientated: B – Safety driven; D – Order driven; F – People driven; and H - Synthesis driven). Norms can then be tagged, and analysis of Spiral Dynamic ideas can then be considered in context of the system space, and inner world model objects, attributes, values, and relationship. Norm tags could, for example, be linked to norms to signify Kegan's levels of thinking – i.e., what norms are primarily linked to socialised thinking, and which are critical to self-directed thinking. Having this information would allow us to model UG student thinking, and potentially highlight areas where thinking process could be evolved. This potentially might be inclusion of ERG (Existence / Relatedness / Growth) metadata to monitor improvement and/or highlight where student get stuck. The possibilities seem endless.

Although the tagging system, if used with a non-standard model, would have to be personalised by the local educator, and he/she would have to be aware that universal acceptance of that tag ontology is unlikely, yet it seems good to allow the holistic model to be stretched beyond its original business information system scope.

Critical Evaluation

I suggests using additional data tags to support use of the holist model in a wide range of information system-based domains. Consideration of extensibility seems appropriate to encourage use in a wider scope of subjects where complex system of system thinking is critical.

6.5.3 Critical Evaluation of Artefact 9

Artefact 9 has considered the issues of motivation, morals, and extensibility. Through discussion I have proposed possible theories and models that could be incorporate to artefact via the augmentation of norm with metadata. Concerning motivation, the research suggests the combined use of four models, i.e., 1) Maslow's hierarchy of needs; 2) ERG Theory; 3) Herzberg's dual factor theory, and 4) McClelland's acquire needs theory. For consideration of morals, the research suggested optional inclusion of six moral foundations, as proposed by Haidt et al. (2012), which are care / harm, fairness / cheating, loyalty / betrayal, authority / subversion, sanctity / degradation, and liberty / oppression. Via consideration of motivation and moral factors, when combined with emotions (as discussed in artefact 8), I present a model that is (vanilla) able to represent, associate, and analyse a wide range of human factors – and the impact this has on system conceptual, informal, formal, and technical norms.

This use of metadata also facilitates extensibility, and the possible use of additional models (as may be required by a future users), which makes artefact 9 potentially capable of being adapted for use in a range of domains where teaching of complex interplay of systems is a problem.

6.6. DSR Evaluation

In this section I will undertake a DSR evaluation. This will be done using two approaches 1) to assess critically whether artefact nine (as-is) is able to functionally able to combine the information presented in other models within a single model (see section 6.6.1), and 2) to undertake a formal expert elicitation (see section 6.6.2), where feedback is captured from experts, i.e. experience university lecturers and professors, to assess each of the artefacts 1-9 via consideration of the emergent model components.

6.6.1. Consideration of Methods

The information systems models currently considered in MM258 include: 1) Nadee et al. (2017) dual aspect model, which introduces students to the idea of business norms and norm conflict; 2) Venkatesh et al. (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex dependency model considering technology system acceptance; and 3) Pankratz and Basten's (2013), which introduces students to a complex theoretical failure model. In the following sub-sections I consider whether or not the artefact 9 would be able to duplicate the core aspects being presented by each model.

Dual-aspect model - Since the dual-aspect model was used as the DSR kernel theory, and many of the issues highlighted by Winai Nadee were critically resolved throughout the DSR process, I can confident that the detailed consideration of norms, and norm conflict is considered in this final artefact model. A concern was raised in the initial evaluation that input complexity was a problem (see section 5.6). Due to the additions made in artefact 6, i.e., wrapping artefact 5 within an IPO model wrapper, this input complexity issue has been resolved. The final model does not allow us to visually represent the conflict of system by overlapping groups of concentric circles, however i) the functional consideration of overlapping norms is still practically possible, ii) the model is more accurate - due to consideration of external influences, and iii) the simplification of input complexity gives educators the opportunity to discuss both a) the implications that input channel and perception have on the ability of an system to complete effective processes, and b) that a system's world model, and therefore its long-term behaviour, may be significantly affected by perceptual, physical, information assimilation, and interpretation problems. In summary, although not as visually simple, artefact 9 is able to represent all aspects of the original dual-aspect model.

UTAUT2 Factors - In section 5.6 we showed how Performance Expectancy (PE), Effort Affordance (EE), Social Influence (SI), Facilitating Condition (FC) and Price Value (PV) could be satisfied by artefact 5. We observed, however, that Hedonic motivation (HV) – i.e., a user's perceptions of the fun or pleasure derived from using a technology" (Venkatesh et al. 2012), Habit (HB) – i.e., "the extent to which people tends to perform behaviours automatically because of learning" (Venkatesh et al. 2012)", and behaviour were not explicitly considered in artefact 5. In artefact 6 we added a perception layer. In artefact 7 we added a discrete behaviour layer, and separated input (perception) and output (behaviour). Moreover, we critically considered a number of interactions that can exist between the system's perception, behaviour, inner-world model, and reasoning layers; allowing the representation of model issues including unconscious reactions, observation, habit / intuition / heuristics, and the act of reasoning (composed of assimilation and reconstruction links). In artefact 8 and 9 the research proposed extensible argumentation of the model using subjective metadata, i.e. to collect and link norms to metadata information; supporting the consideration of subjective drivers, such as emotion, motivation, and morals. Using this subjective metadata Hedonic motivation (HV) can now be addressed – i.e., by concerning joy (a core part of Plutchiks' wheel of emotion). Habit (HB) is addressed by adding a direct link between the inner world model and the behavioural layer – implying unconscious learnt behaviour that is triggered without the requirement of conscious thought. In summary, although the UTAUT2 model constructs could not be represented using earlier artefacts, this is now possible in artefact 9.

Pankratz and Basten - In section 5.6 we stated that most failure factors identified in the Pankratz and Basten paper are due to human factors, and although these factors potentially could be represented in norm structures, the mechanism of human reasoning, the separation of perception and behaviour, and the inclusion of emotion, motivation, and moral metadata all helps in the modelling of human behaviour in artefacts 8 and 9. The ability to link norms to motivation factors (i.e., Maslow's hierarchy of needs, ERG Theory, Herzberg's dual factor theory, and McClelland's acquire needs theory) and/or moral foundations (care / harm, fairness / cheating, loyalty / betrayal, authority / subversion, sanctity / degradation, and liberty / oppression) allows the final model in representing a wide range of human factors – linking human factors to system conceptual, informal, formal, and technical norms. I systematically considered the 54 failure factors presented by Pankratz and Basten and believe that artefact 9 could be used to support critical discussion for all concepts and dimensions presented in appendix A. If a specific factor was found not be considered, however, the ability to add additional (extensible) metadata would support in relevant adaption required to consider any unresolved issues, and link this to system objects, attributes, variables, and relationships. In summary I conclude that artefact nine meets the DSR (Design Science Research) satisfaction criteria defined in this thesis project.

Hevner et al. defined 7 DSR guidelines: 1) the DSR solution should be designed as an artefact. Design science must produce an artefact in the form of construct a model, a method, or an instantiation; 2) The artefact must be developed to produce a solution that satisfies an important and/or relevant business problem; 3) the utility, quality, and efficacy of the artefact must be "rigorously demonstrated via well-executed evaluation methods"; 4) The outcome must provide a clear and verifiable contribution in the area of design artefact, design foundations and / or design methodologies; 5) The research must apply rigorous methods in both the construction and evaluation of the design artefact; 6) the DRS research process is a cyclical problem-solving process, where solutions are tested against each other and against their efficacy for solving the problem. Moreover, the search for an effective artefact requires utilising of available means to reach desired ends or satisfying laws in the program environment; finally, 7) the solution must be presented effectively both to technology and management orientated audiences. The aim of using DRS was address research question 2, which asked "Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?" Although in section 6.6.2 the model will be formally evaluated by IS expert, I personally believe that, in context of MM258, the final artefact 9 is able to representing the complex system thinking issues issue required to teach complex systems thinking. As such, I am confident that the answer to research question 2 is 'Yes – yes it can'.

6.6.2. Formal Expert Elicitation

Since achieving satisfaction is critical to DSR (Simons, 1969), a formal evaluation is critical to the completion of the design science methodology cycle (see figure 3.5). Formal expert elicitation is a structured process used to gather and synthesise expert opinion, feedback, and/or prediction concerning the outcome of a specific study (Morgan, 2014). The steps involved in expert elicitation are: Define the scope and format of the elicitation, select experts, design of elicitation protocol, preparation of the elicitation session, collection and reporting of expert judgements (Knol et al., 2010). Expert elicitation has been used widely to gauge expert opinion (Morgan et al., 2006); e.g. the health impact of fine particle air pollution (Cooke, 1991), the likely nature and extent of climate change, and the likely cost and performance of various energy technologies (Zickfield, 2010). Formal expert elicitation was used here to capture feedback concerning each of the DSR artefacts presented in this thesis. In the following sections, I will expound each step in more detail to provide a formal expert evaluation of the emergent model components.

Define the Scope and Format of the Elicitation

To evaluate all key emergent artefact components, it was critical to explicitly define an elicitation narrative. Following the steps, as presented in the thesis, I asked experts for feedback concerning: 1) any issues and problems they have experienced when teaching information systems; 2) use of the Design Science Research (DRS) methodology; 3) Artefact 1 – the dual-aspect model (including: selection of the kernel theory, the norm ontology, any issues concerning interaction of norms, issues related to system conflict, and testing of the kernel with UG students); 4) Artefact 2 - the flux model (including the direct connection to external influences); 5) Artefact 3 – additional of system goals; 6) Artefact 4 – i.e. the use of i) an inner world model and ii) belief and believability as metadata; 7) Artefact 5 – i.e. the handling of norm conflicts; 8) Artefact 6 – addition of the perceptual layer; 9) Artefact 7 – explicit addition of Behaviour; 10) Artefact 8 – the considering of emotions; 11) Artefact 9 – adding motivation, morals, and extensibility, and finally 12) any additional comments or feedback. To acquire feedback the expert elicitation required two stages: 1) all experts needed to watch a pre-recorded presentation (approximately 1 hr) that contained a step-by-step description of all emergent artefact components, and 2) all experts were required to attend a semi-structured interview, to facilitate the capture of feedback concerning the artefact components.

Select Experts

To maximise focus and use of resources, I followed the suggestion of Neilson (2024), which states that qualitative expert feedback should initially be captured from just five varied domain users. If considerable feedback variation occurs then additional users should be used. Accordingly, five participants were approached to conduct the expert assessment. Experts were selected because they possessed a range of experience, came from a range of different countries and cultures, covered a range of knowledge domains, and focused on a range of research interests (see table 6.3).

All participants had a least 3 years of experience teaching information system modules within higher education institutions. Two interviewees, however, had over 20 years of teaching experience (In1 and In4). Three of the experts (In1, In4, and In5) were currently teaching in UK institutions, yet only one of the experts (In4) was born and raised in the UK. All experts had experience teaching in non-english speaking countries. Experts also taught information systems to students within a range of courses, including business, health systems, accounting, management, project management, supply chain management, and Information Technology.

Table 6.3. Interviewee Sample details.

Interviewee	Role	Experiences
In1	Professor of Business Informatics	35 years of experience teaching and researching (internationally) in the domain of Information Systems. Extensive HEI experience teaching UG information systems modules, and PG business informatics modules. The interviewee's has extensive experience using business norms, and has a research focus relating to organisational semiotics.
In2	Professor in Health Informatics	Currently the head of an IS department (in Saudi Arabia) with 15 years of experience of teaching IS to UG students. The interviewee's research focus is liked to Health Information Systems, with particular focus on patient acceptance and IS adoption issues.
In3	Associate Processor, Corporate Trainer, Management Consultant	15 years of experience (in Pakistan) conducting teaching and corporate training in the fields of Project Management, Supply Chain Management and Information Technology. Current head of the MBA executive programme. The interviewee's research focus is on Barriers impacting Education Technology Implementation.
In4	Associate Processor in Information System	20 + years of experience teaching in computing and business departments (mainly in UK). Strong technical knowledge, with a focus on human factors research.
In5	Graduate Teaching Assistant	Experienced UK based researcher in Human Factors and Cognitive Neural Science. Originally from India, this researcher is currently involved in teaching a number of HE modules concerning information transformation.

Design of Elicitation Protocol

To support remote capture of expert feedback data (as only two of the experts were physically available), it was essential to develop a pre-recorded description of the emergent model components. A presentation slide-set was developed to cover all 12 elicitation narrative steps (i.e., discussion of issues and problems experienced when teaching information systems, consideration of using DRS in development of the solution, Artefacts 1 – 9 respectively, and any other issues) - see http://www.stephenrgulliver.online/DBA/EE.pptx . The slide-set content was presented to the PGR community at a hybrid Henley seminar. This hybrid seminar session was recorded (using teams), edited (using Camtasia), and distributed (online) to experts (available at http://www.stephenrgulliver.online/DBA/EEVideo.mp4). The use of pre-recorded slide-set and video ensured that i) all experts received and viewed exactly the same information (both content and delivery), ii) that checks could be systematically done on the quality of the recording (and that the delivery was not impacted by local bandwidth or technology issues), iii) that experts could rewatch any sections (if required or desired) to support their understanding of the emergent model constructs, and iv) that the order in which the emergent model components was presented was consistent; thus supporting interview capture, data analysis, and content presentation.

Preparation of the Elicitation Session

Once experts were invited, and had agreed to being involved in the session (with all interaction and agreements recorded via email), links to the slide-set and pre-recorded (1hr) video were sent to all experts. Experts agreed to watch the pre-recorded video in advance of a mutually agreed interview meeting. Interviews (as required) were conducted both physically (In1, In4) and via teams (In2, In3, In5). Permission was granted to record each of the face-to-face interviews, which took approximately between 35 minutes and 1 hr. Experts were not paid for their time. Within each interview, the 12 elicitation narrative steps (i.e., discussion of issues and problems they had experienced when teaching information systems, consideration of using DRS in development of the solution, Artefacts 1 – 9 respectively, and additional thought and comments) was discussed. If the expert had feedback, then this was systematically probed and user feedback was recorded. All recordings were then analysed, using thematic analysis, using the 12 elicitation narrative steps as pre-codes.

Collection and Reporting of Expert's Judgements

The following text systematically presents expert feedback concerning the 12 defined elicitation narrative steps.

1) Initial Thoughts and Feedback concerning teaching IS

This initial step allowed the experts to provide information about reoccurring issues and problems that they have encountered in their career concerning the teaching of IS. Discussion in this area was themed into two sections, i) IS definition and ii) complexity of systems thinking.

IS Definition - In1 raised the point that student have often (especially in the past) had a problem with the definition of information systems. In1 stated, *"I guess I now have considerable experience of teaching IS models. In the early years, students always equated information system with information technology (so computer science). This misunderstanding can generate significant initial resistance from non-computer science students. Of course I tell students that an information system might be an organisation, a person or a technology. But students sometimes have a problem to accept that an organisation is an information systems. I think this has improved recently in the UK, but this view is still an issue in many countries".* Interestingly, the view that IS=IT was less pronounced in human focused domains. In2, who teaches health systems, stated *"You say in the presentation that humans, technology, and organisations are all systems. I think this is a fair starting point, and it is very applicable in the domain of health systems. In hospitals it is important to consider how the people interact with the technology, and how this works in hospitals (the organisation). IS failure is common in health, and failure is significant. Having a model that allows us to align human and technology is very useful."*

Complexity of Systems thinking – In4 raised the point that students often seem confused when facing IS for the first time. *"In computing we mostly talk about the development of predictable formalised systems. Despite this relative simplicity, I'm very familiar with the blank stare of confusion when teaching students about abstract systems ideas". Such* statements, align to my own experiences, and the DBA hypothesis. In5 considered - *"I don't really know if undergraduate students are taught prescriptively in A-levels, or whether this is due to the pandemic, but students seem to think that there is one correct answer. When students realise that they can't just learn the answer by heart they seem to get very concerned and anxious. Sometimes there is a correct answer in IS, but mostly there are options (some better and some* *worse). About half the students struggle to initially understand when there's not a single correct solution, and it confuses them when the best answer changes depending on the situation".*

Initial issues highlighted whilst teaching IS confirm i) the importance of students appreciating that IS is more than just IT, and ii) that a fair proportion of students think that IS should be a one-sized cure-all (or a silver bullet) – a view that is often identified in the opinions of problem project managers (Pankratz and Basten, 2013).

2) Use of Design Science Research (DSR)

In2 was the only person with feedback concerning the use of DSR. In2 stated that *"I feel you shouldn't mention the use of design science. I don't disagree with your use of this method, but personally I'm just not really interested in it, and I think students would feel the same. I feel that it pulls me away from the core value of the model. I guess I'm more interested how this model can be used (not how it come about)."*

Clearly, use of DSR was not see as a problem by any of the experts. Experts (and we assume students) were more interested in the model – i.e., the outcome of the research rather than the steps taken to develop it.

3) Artefact 1 - Selection of the Kernel

Artefact 1 is the dual aspect model (see figure 4.5), which consists of four concentric circles ordered – from middle out - concept, informal, formal, and technical. The feedback from experts was themed into three issues, i) the construct of norms, ii) interaction of norms resulting in conflict, and iii) the interaction of Norms.

Construct of Norms – This theme relates to how norm types and the relationships that exist between different norms. In1, who uses norms in their teaching, said *"In my classes I use norms to talk about company vision, mission, and strategy - this kind of cultural mindset. I teach norms as a compositional part of the organisation. Someone will only see an organisation from outside, which is the informal part. That's what you see if you come to it organisation, and then (only if you go into further detail and analyse further) you will see the structure, and the process. The IT system is very small part of the whole. I guess I see the layout of norms more like a Venn diagram than the dependent relationship, which is how you present norms in the first model (i.e. the dual-aspect model). The way you presented it is not wrong at all, but you* *place focus on the relationships, which is quite different to some of the previous models {such as Ronald Stamper's organisational Onion} where the technical is the ultimate expression of the informal. I think this is not wrong, but the use of norms in this way has to be made clear to students, as people may have previously encountered other models and they might be confused by this difference in definition".* In4, who teaches mainly computer science stated that *"I don't teach Norms, and until now I've never really considered using them. I guess I think in terms of software, but it's interesting that the processes of business requirements capture, and software development, aligns step-by-step with conceptual / informal / formal / technical norm stages; with each circle moving the process closer to development of a technical outcome. Students, in my experience, however, find it hard to capture business requirements – it's often something that student do well or can't do at all. I wonder if capture of norms might be a problem. I can see technically how a change in the object/entity/value could trigger an activity, which is similar to an CASE statement (depending on the condition). I think students would understanding this."*

Interaction of Norms Resulting in Conflict – This theme relates how the dual aspect model can be use to show interaction points (see figure 4.6). In2, when asked about the issue of conflict, stated *"The idea of alignment in artefact 1 is really interesting. I particularly like the times that you described the models with examples, which made it more understandable. Perfect. It is really important to use relevant examples to help students to see what is going on".* In3 pointed out the *"The speed that you presented this information within the seminar was too way to fast for UG students, but we wouldn't be presenting to UG students at that speed. I would be adding discussion and examples. So – no. I don't think there'd be a problem teaching students about this. It is a useful model for talking to them about many things (including conflict). I don't think there would be any issues". I5 stated that "the idea of system interaction is quite powerful. Students by 18/19 have normally experienced social conflict (even if it's in the playground). I think the idea that differences exists, and that these differences can cause tension would makes sense to them."*

Testing with UG students – This theme relates to the some experts liked that the model has been empirically validated. In2, particularly, liked that the kernel theory has been tested as part of the DBA. *"Your focus on testing the different types of alignment seemed brilliant. It is important to realise that change is not instant. A new tool, or new process, can be implemented into the hospital, but it takes time for this tool to be adopted and used practically by staff (and* *accepted by patient). Normally people (over time) change their habits, but some people refuse to change."* In5 stated that *"From a teaching perspective, the dual aspect model would be a useful tool to start seminar discussions, and the fact that this has been tested with UG students is good to know."*

Feedback suggests that the kernel artefact, as was evidenced by in chapter 4, is clear and understandable – supporting interesting discussion concerning systems interaction. Experts also like that this has been tested. It is important, however, that students are provided with a good introduction to norm definitions, as other similar, but conflicting, definitions exists (as discussed in table 4.2).

4) Artefact 2 (The flux model)

Artefact 2 presents the same norms, yet changes the interaction ontology (see figure 5.4) to support external interaction with informal and formal norms – as suggested in Nadee et al.'s SEM model. Four themes were determines, which were i) Make sense, ii) Good access to external stakeholders, iii) Inner conflict loops, and iv) Harder to visualise. The following sections will consider each of these in turn.

'Makes sense' - In2, In3, and In4 all used the term 'makes sense' when talking about the change from the dual-aspect model ontology to the flux model ontology. In2 stated that *"this makes sense to me".* In3 said "*The shift to the flux model makes sense, and the three different types of conflict was good. You explained it with a good example, so that was very clear to me".* In4 claimed *"Initially the reason and importance for the change in structure was not clear to me, but when dealing with software development it's clear that there is a clear link between what you aim to achieve and what you're able to technically implement. If specific technical skills don't exist in a project team, then it makes sense that the technical solution can't be implemented effectively - and that additional technical training is required, additional staff is needed, or an alternative solution has to be found. The new layout of norms would be quite good at considering these links between intention, the plan, and the realisation of that plan. I like it!".* It seems that mostly experts are quite positive to the ontology shift.

Good Access to External Stakeholders - *In1 claimed that "I would certainly not claim that there is only one way to layout norms, and your interpretation seems fair. I appreciate the value that this layout supports the automatic (remote) management of technology. The original model* *(i.e. the dual aspect model) was designed to represent the ontology of an organisation, and was not designed to consider interactive functions. Your interpretation would allow technology to be exposed to other stakeholders, and this changes the nature of the model. The presentation of the inter, intra, and inner conflicts is useful to this supports the consideration of the impact, and resolution, of either an internal or external change. I do like the idea of ongoing dissonance, a factor which is not clear in the artefact 1 model. This makes sense in all types of systems (human, organisations, or technical)."*

A couple of issues were raised by experts concerning the visual layout of the flux model:

Inner conflict loops – In3 "I found the little loops (the inner conflict loop) visually quite unclear. Maybe you could draw it more clearly, as I initially thought it was a closed circle, which is slightly confusing."

Harder to Visualise – In5 stated that the layout of the flux model made it harder to visually represent systems interaction -*"The second model (the flux model) seemed visually more complex, and the interaction between systems is slightly harder to visually appreciate. Most interaction will still be technical-technical, but the nine interaction points (see figure 4.6) is easier to visualise in the first model. If you have complete interaction then this is quite easy to visualise in the first model, but how would you draw this on a board using the second model."*

Better layout of the inner conflict loops is an easy fix. Moreover I agree that the flux model does not support (to the same extent) the ability to represent visually the interaction of systems, but the ability to externally influence I / F / T norm layers does more closely representation reality (see figure 5.2).

5) Artefact 3 – System Goal

In artefact 3 we added a line between external social memes and active concept norms, thus allowing system concepts to be influenced by external factors (see figure 5.8). Six themes were identified by experts, which were i) no concerns, ii) is it even relevant for technical systems, iii) supporting system evolution, iv) problems representing concept norms, v) a need to improve the lines, vi) concept conflict loop. Each of these issues will now be considered in turn.

No concerns – The use of a single line to update goals was generally accepted by experts. For example In1 stated that *"I think this solution is very pragmatic. Indicators, and selection of current norms, will be chosen based on the context. If the organisation is a not for profit, such as a charity, then this organisation will have a very different influence than a profit driven commercial company. This will influence the norms that the organisation uses. This makes sense to me"*. In5 said *"I don't think different people having different goals is hard to appreciate. We've all known people who are driven by different goals. Again this is an interesting tool for getting students to reflect on their own goals. I initially wondered whether this applied to technology, but it makes sense that technology is designed to obtain different outputs."*

Is it even relevant for Technical systems – The question whether or not goal updates were needed for technical system needed was raised by In5 above. This view was echoed by In4 who said *"Technical solutions (maybe with the exception of AI) rarely have mixed intentions. Technical systems are designed to achieve one outcome - so I don't think the additional concept line is needed for most technical solutions. It's true that sometimes technology is repurposed (normally by humans), but the technology is not the thing at fault – and the repurposing occurs in the technical norm of another system. I guess there's a conflict between what the technology was designed to do, and what the user chooses to use it for. I'm not sure how you would model this."*

A number of positives, i.e. functionality benefits, were highlighted by expert feedback:

Supporting System Evolution – The ability to change the focus of the system was commended by In3, who stated *"I was initially a bit confused why the concept needed to be updated (as this is not always true for organisations and technologies) but systems evolve and paradigm shifts night occur in the solution use"*. The ability of the system to shape itself, i.e. in order to align with the needs of the local culture was also seen as a positive benefit. In3 claimed that *"the idea of linking culture is important here. We often learn what we should be aspiring to achieve from those around us - for example our parents, friends, etc. I think that the students that I deal with will have very different drivers to students in the UK. It would be an interesting study to consider this. I guess these differences will be represented across the four different types of norms (Conceptual / Informal / Formal / Technical)."*

Problem were raised by experts concerning two categories of issues i) problems representing concept norms, and ii) the visual layout of the model.

Problems representing concept norms – In4 pointed out that *"The updating of the goals makes a lot of sense, however it's not quite clear how the goal (concept) norms would be represented in practice. Norms could have additional meta data for possible KPI factors, but it seems slightly impractical. I get the feeling that the idea is good, but I'm not sure that a single technology exists that would allow this to be easily actualised."*

In reality this point is valid, and a single technology does not exist which would support this need. Just because technology is currently unable to support this, however, does not mean that the need for such a solution should be ignored. If a practically implementable solution is to be found, this valid criticism, raises a flag that norms definitions, norm capture, and norm storage are areas for future research.

Two issues linked to the visual layout of the model were raised:

Improve the lines – In2 pointed out that "I don't have any issues with the idea here, but the lines used, could be more clear. What I mean is that input/output lines and conflict lines all use the same style lines, but they seem to do different things. I would suggest a better use of distinction of line type, as input lines occur once, and conflict lines are 'triggered' if conflict exist. Also input / output is not clear in this model. I know (because I watched the video) that you change this, but initially I was distracted by this point. Maybe the input / output line should be solid (with no arrows) as it is perceived and assimilated, and the conflict lines could be dotted (to signify that this sometimes exits)."

Concept conflict loop - In2 also pointed out that "I think that potentially goal conflict occurs. In the presentation you talked about having multiple goals, but having multiple goals suggests that there will be conceptual conflict yet there is no inner conflict loop which implies that this is not possible." In3 raised a similar point *"If this input line means that there is a possibility of having multiple goals, then there may be conflict between concepts. I am not if this has been considered in the model. I think there should be a type 3 conflict (i.e. an inner conflict) for multiple concept. It would be good to add this in the final model."*

Both points, i.e. improving the lines, and adding a conflict loop, are reasonable, and easily solved.

6) Artefact 4 – Inner Worlds Model

In Artefact 4 we added the ideas of i) the Inner Worlds Model, and ii) Belief and Believeability. Six themes were identified in feedback, i) the need seems clear, in order to ii) recognise difference, but this means it is iii) hard to know how generic norms should be defined. Two positive were identified, i.e. use of an inner world model iv) supports machine learning, and v) supports behavioural change activities. The main concern is whether vi) some people are unable to understand their own reality. Each of these issues will now be considered in turn.

The need seems clear – It seems clear that capturing information about the systems inner world model is important. In5 observed that *"I don't think I'd thought about knowledge like this before. If you want to think about something, you've got to build it one something – captured from life experience or the experiences of others - or you have to create the something 'in your mind'. Education is simply the building up of this catalogue of things, how these things work, how you can use these things, why these things mater, etc. It makes complete sense that no two people will experience 100% of the same things (in the same way) – so I guess no two people will have the same understanding of the world".*

This recognition that everyone is different was also explicitly stated by In2.

Recognising Difference - In2 said *" I like the use of the inner world model. It seems good to recognise that we're all different. We all experience things differently, and therefore we have different views of the same events. This is a point that a point that we often discuss, but it is important to understanding conflict."*

The problem of supporting difference, and how you define when to create a new norm was raised:

How generic will norms become? In1 said *"I can see scenarios where you would use separate norms for different conditions; and some outcomes would be better than others. You might like doing something normally, but not on a Friday (maybe because you are generally tired on the Friday). The issue is whether these are differences are adapted instances of the same class* *(meaning norm), or different classes (meaning norm) linked to a difference in the condition. The norms and the structures tell us how t the world works – these norms are mostly generic. I am not sure how you would link metadata to these structures in the inner world model. It is clear to me, however, that you will need to link the norm and the conditional context, in order to link the norm/context structure with messy human situations."*

If you were able to record all type of norms, and link subjective metadata to norms, then experts claimed that this would be of considerable value to support machine learning and behavioural management:

Supporting Machine Learning – In3 claimed "*I don't have any issues here. This idea (i.e. the inner world model) is attractive as we move towards machine learning, but the problem will be where the data comes from."* In5 commented that *"I am not sure that the belief / believe ability point makes much sense in computer science, but I guess you could test that the outcome is what you expected it to be and use this to learn automatically. That would provide some interesting opportunities for computer learning".*

Supporting Behavioural Change – In4 stated that *"Hofstede talks about the 'Software of the mind', which talks about companies and culture as human software. I guess the inner world model is like an extension of this idea, but the claim that all complex system have software (inner world model) makes some sense to me. I wonder if this idea (if you could make it work) could be quite useful for modelling and changing group behaviour". In2 similarly observed that "the addition of subjective meta-data allows the separation of objective and subjective experience. It reminds me of the behaviour change wheel, and some other similar models, that considers society norms and patient emotion when you are trying to design behavioural change plans. The inner world model would be quite useful here."*

Some People are Unable to Understand their own reality – In2, who works in the health care environment, pointed out *"that many people - particularly uninformed or ill people - might struggle to separate their subjective and objective realities. What ill people feel is often their whole reality. The people this would really help is initially going to be the people who oversee, care for, or support such ill people."*

It seems that the concept of the inner world model is generally accepted by experts, since it i) supports the recognition of difference, and ii) functionality that could aim machine learning and behavioural change technologies. There are, however, a number of practical barriers to implementation of this concept, e.g. creation and management of norms, that need to be solved before such an idea could be realised for generic use.

7) Artefact 5 – Handling conflict

In artefact 5 a conflict handling mechanism was presented, which combines objective and subjective data, in a n-dimentional space, to identify which norm should be used (see section 5.5). Three main themes were identified, which were i) love it, but it is too complex, ii) could be useful with AI, iii) and lacks testing. Each of these issues will now be considered in turn.

Love it, but it is too complex – In2 said *"I see that this might work, and this is very interesting, but I think it is quite hard to prove, and my student might struggle with these idea (as my students always turn off as soon as I try to use mathematics). In3 also said "It makes a lot of sense to me, and it's very interesting that you can include all possible factors here, so practically it would be very flexible. If you found out there are 20 factors that impact the selection of a norm, then this would not be a problem - but adding too many variables in the description will make the description too complex for students to understand. Explaining this idea to students will take a bit of time. You would need to add a number of additional worked examples, and some practice cases before you start dealing with more than 3-dimension in Euclidian space." In5 also said "I think students would find this part quite confusing. The term dissonance is not one that students would be familiar with, and it's not something I would want to teach."*

Experts can see the potential of an automated conflict mechanism, but have concerns whether students would be able to appreciate it. I agree that this mechanism is not something you would throw (as-is) to undergraduates. I was pleased that experts did recognise the potential of the mechanism – especially in context of AI:

Could be useful with AI – In4 said *"You wouldn't need this for software development, but I can see how this would be extremely useful in artificial intelligence - particularly when trying to understand human actions. I guess the issue then is how you define and capture subjective factors (belief / believability). How can a computer capture how believable something is? I* *guess you could have a record whether or not previous outcomes were true/false/undefined, but again this is more meta data, and the management of a model might become quite complex."* In1 also claimed *"An AI could use this to consider the behaviours of individuals or groups of people"*.

Most experts were interested in the idea, but some resistance did occur due to the fact that this is currently untested:

Lacks testing – In2 *"Maybe you could test the model using existing data. I think that would make a good paper, but it needs a lot more work to validate this before you would rely on the ideas."*

I am encouraged that experts were not against the use of an automated conflict handling mechanism, but it is clear that additional research is needed to i) define and capture subjective factor data, and ii) test the mechanism in a range of possible domains.

8) Artefact 6 – Perceptual Process

Artefact 6 involved the wrapping of artefact 5 within an IPO model, to show that processing is only possible if the information is available within the model. Three themes were identified, which were i) no issues, as ii) perception is important, however iii) the form of the information being considered is not being considered. Each of these issues will now be considered in turn.

No issues – All experts appeared positive to the use of a IPO wrapper. In1 said *"I have no issue or comment on this step. The idea of only processing what you perceive seems obvious to me. This idea also links nicely with the IPO model, which I know from experience is understood by undergraduate students"*. In4 mirrored this statement saying *"This is fine. We teach students the IPO model at the start of their degree, and it makes sense to use IPO here as it defines the scope of the system. When analysing data I often tell my students 'rubbish in, rubbish out', which is similar to the point being made here. I hadn't really previously considered this in terms of organisational and human input, but it makes sense"*. In3 said *"No problem with this bit. It makes sense that you can only process the information that is available to you – and that this is true for technology, people, and organisations". Finally* In5 said *"I don't think this is a problem. Clearly a blind person will not be able describe the visual appearance of an object –*

but they might be more aware of the size, texture, or smell. I don't think students would struggle with this".

Perception is Important - In2 highted the importance of perception saying *"I like this one! I studied perception as part of my PhD, so difference in perception is important to me. With the earlier artefacts I did think 'it might be possible that some people would miss something'. I didn't talk about it at the time, but I am pleased that you added this here. This issue is definitely an important thing!"*

Although everyone agreeing that consideration of perception was of value, In 4 raised a concern that the format of information, which is vital to the practical implementation of the model, was not being considered:

Format of the information is not considered – In4 observed that "the nature of the information is not considered in the model, and this is critical in computer science, as you need to know the form of inputs in advance if you are going to process the information effectively. Adding some consideration of input type might be useful if this model is going to be realised." This is essential point, and is critical to the practical implementation of norms. This point, however is linked to the definition, capture, and storage of norms, which is not considered within the scope of this DBA.

9) Artefact 7 – Explicit addition of Behaviour

Artefact 7 relates to the explicit inclusion of a behaviour layer, which allows the separation of perception and behaviour, and facilitates the modelling of both conscious and unconscious behaviour. Four themes were identified, which were i) generally insightful, ii) improves information flow, iii) important to consider the human dimension, and iv) useful in the education. Each of these issues will now be considered in turn.

Generally insightful – In5 claimed *"I found this really interesting, as it's surprisingly simple to understand. I think students would be fine with this. It would also be really easy to create loads of examples and discussions for class. I'm actually quite impressed by how much theory and practice can be explained using four lines. I've done quite a lot of reading concerning behavioural economics, and this would be good to explain some of the basic ideas to students"*. In1 observed that *"there are lots of interesting insights here. I am not sure that all the ideas* *are 100% perfect, yet it is sufficient to highlight the principle. The final model, unlike the first model, allows you to represent human input and processing"*. For In4 *"the separation of input (perception) and output (behaviour) is interesting."* In4 also liked *"the use of processes (reasoning) as a separate (simple) line, as this shows a distinction the output being driven by an automatic (hardcoded) response, or a calculated (reasoned) outcome. It seems important to know if behaviour is hardcoded (because it won't change easily). I think you could use these layers to storyboard the flow of software. There are a number of really good modelling languages, such as UML (which you do not mention in your work), yet they have separate views, and this can seem confusing to students. I like that you have this all in a single sheet. It seems similar to BPMN, but it is focused on the actions of a single stakeholder. Nice – you should certainly publish that bit.*"

The general positive feedback was compounded by three additional points:

Better information flow – In2 observed that *"the separation of perception and behaviour resolves the flow problem identified in artefact 4. The layout of the four levels is impressive - and useful when talking to student. Although not all student will understand it (there are always some), I think the majority would get it very quickly (especially with some good examples). You also don't have to present students with the whole model in order for them to understand the point of the four lines, and the interaction between them – so it is quite easy to use as a standalone idea. I can certainly see myself applying this when considering patient behaviour change in my health studies."*

The importance of the human dimension – In3 declared *"What I like is that your description uses both technical and human examples. This ability to embrace the human (which includes culture) is important to me, as ignoring the human IS dimension (in my experience) can cause conflict and barriers. I think it is important to include both perceptions, as students will start to see systems as being sociotechnical. I think there is a lot in here that would support publication and student discussion."*

Useful in the Educational domain – In3 commented that *"I think use of the levels would be very useful when developing new educational programmes. For example, you can't assume that the student will possess the knowledge within their inner world model. You could develop activities that more systematically identifying where people have problems, and maybe even* *personalise the assimilation of ideas (based on their gaps). I do think this could be quite a useful tool in this context."*

I was pleased by the positive feedback concerning this part of the model, and was surprised by the number of people who could see possible planning and development application in their domain.

10/11) Artefact 8 & 9 – Considering Emotions / Motivation, Morals, and Extensibility
Interesting interviewees provided limited feedback concerning Artefacts 8 and 9. I personally believe that this due to the fast speed of the presentation, which limited my being able to present detailed information about all emotional, motivation, and moral models discussed in the thesis. The primary concern about linking norms to metadata related to the capture of metadata:

Problems capturing this meta data - In2 observed that *"You might be able to observe behaviour (technical), or check rules (formal), but it is very hard to capture information about informal and conceptual norms. Without complex equipment, or without asking someone directly, it would be almost impossible to capture information about someone's goals and informal intentions. How would you capture this information?"*

This is a fair point, and although outside the scope of the DBA, it highlights the fact that for my model to be practically implementable, a number of other problems still need to be considered.

12) Other issues
Within the final elicitation step, I allowed experts to provide any additional comments and feedback. Five key points were raised, which were i) generally the idea seems good, but the video provided a lot of information very quickly, and to use this with students ii) you would need to slow it down. There was, however, a concern that student would see this as iii) no sellable (i.e. of limited instant use to businesses). Finally experts pointed out that, to make the model practically useable iv) additional testing was required and v) a number of problems with subjective data capture needed to be considered. Each of these issues will now be considered in turn.

Generally it seems good – Most experts were generally very positive. For example, In5 said *"In general I think the model is commendable, with good really good life examples and* *illustrations that makes it easy for a non-expert to understand the key stages of the model. When writing up though, it would be good to use the model in context of case examples and comparisons – as I think this will help people see the practical potential of the model.”*

Need to slow it down – In 3 said *“I had to go through the video twice, but on the second time through I did understand all the points being presented. This implies that the speed was just way too fast the first time, but it the model does make sense. Every layer, and every artefact adds something to the previous concept. I can see clearly, however, that explaining this to students (who do not have my experiences) will take time. If you wrote this down, with lots of examples and discussion points for students, then it would be easier for students to understand the whole model.”*

Not practical / sellable - In1 highlighted a good point, however that increasingly UG students are pragmatic in their learning, and they might not be willing to spend the time on a non practical model. I1 claimed that *“I am not sure this model could be taught to undergraduates. It think it would be understood, but you can’t teach this model to students in a single lecture (say 40 minutes) as there is too much going on. This model would be hard to teach quickly, but I wonder if this is something UG students would see as valuable across multiple lecture. UG students increasingly preferring to learn practical / sellable skills. This point is not really about the quality of your model, but about what students want from the education sector. This is a different issue I know, but I do think it might impact whether people show an interest in your work*”.

Model requires empirical testing – A number of comments were made that the model would only be of value when it is useable. In2, for example, pointed out that *“You combine some big ideas here, which I think is amazing, but you really need to test the model. I do think you should try to test it through. I have a grant at the moment that would benefit from this model, but I’d not use it until this has been validated.”*

Problem capturing data – In2 also observed that *‘the main issue, as with my PhD and lots of other behavioural models, is ‘how do you measure the behaviour data?“. If you can find a way to measure behaviour then your model would be very powerful – but without this key element, the impact of the model will be limited.”*

Although the experts highlighted a number of development issues, they were generally positive that the work i) provided some interesting contributions, and ii) the model would be understandable to UG IS student if enough time and examples were developed. It is clear, supported by expert feedback, that the developed model is not useable as a commercial solution, yet this was not the point of the model. Although In1 highlighted that this may negatively impact students engagement with the model, it does not detract that research question has been satisfied.

6.7. Conclusion

In chapter 6, we have introduced artefacts 6 to 9. These iterations systematically allowed i) the wrapping of artefact in an IPO wrapper (i.e. to reduce interaction complexity), ii) the introduction of a perception layer (to allow the decomposition of memes and the consideration of perception), iii) the introduction of an explicit behaviour layer, iv) the linking of perception to the system input, v) the linking of behaviour to the system output, vi) consideration of different forms of thinking, vii) behaviour that have been identified in literature, and viii) argumentation of norms with emotion, motivation, moral metadata tags.

A DSR evaluation was undertaken a) to assess whether artefact nine (as-is) is able to combine the ideas contained within three MM258 models (see section 6.6.1), and b) to capture formal expert feedback (see section 6.6.2). The consideration of functionality (see section 6.6.1) showed that artifact nine (as-is) was indeed capable of combining the ideas contained i) Nadee et al.'s (2017) dual aspect model, ii) Venkatesh et al.'s (2012) UTUAT2 model, and iii) Pankratz and Basten's (2013) failure model. Elicited expert feedback (6.6.2) highlighted a number of issues, but suggested that the model would be understandable to UG IS student if enough time and examples were developed. An updated artefact 9, incorporating expert feedback is presented in figure 6.17.

Since the model has satisfied both evaluations, I feel confident that the final adapted artefact 9 meets the core DSR satisfaction requirement, and therefore positively addresses the second research question.

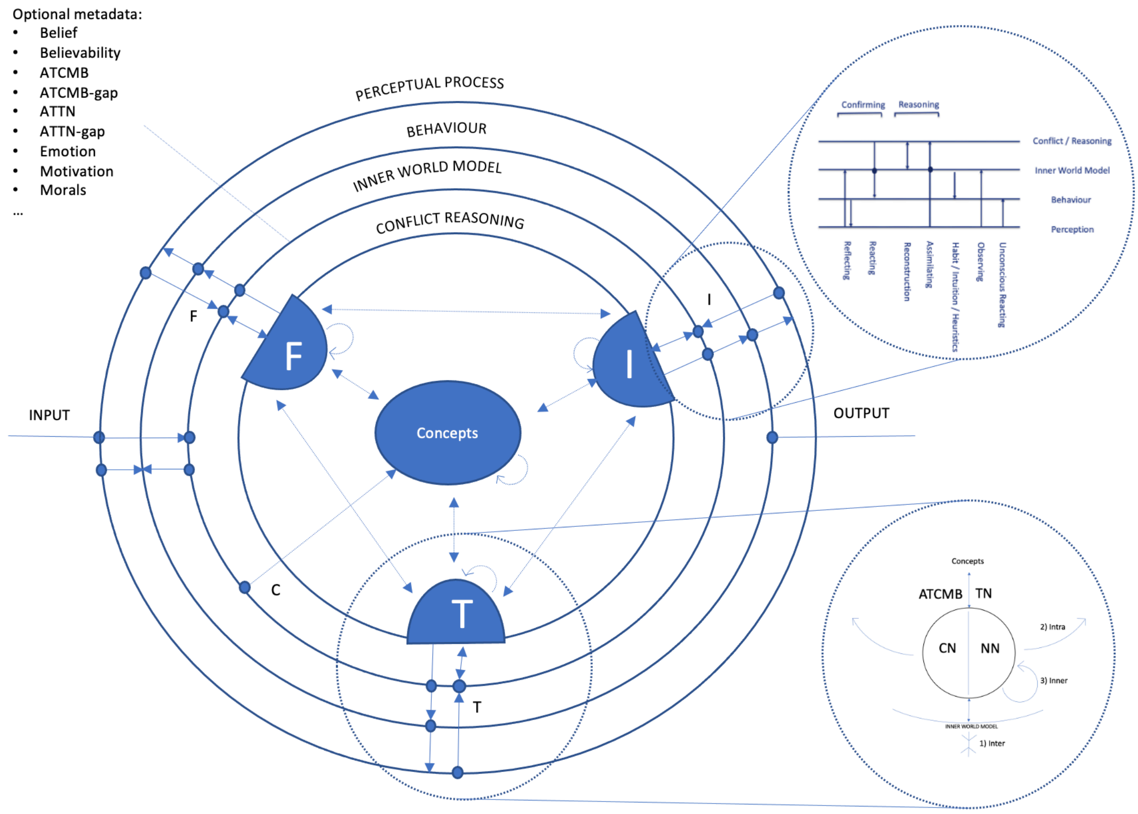


Figure 6.17. Adapted Artefact 9 Holistic Information Systems Model.

Chapter 7 – Conclusion and Personal Reflection

7.1. Introduction

In this final chapter I will: i) provide a summary of the research and conclusion; ii) provide some discussion concerning the main contributions in the thesis; iii) limitations in this thesis will be critically discussed, iv) I will provide some personal reflection concerning the DBA progress, and finally v) a thesis conclusion will be provided.

7.2. Summary of the Research and Conclusions

In this research I proposed that a large proportion of pre-experienced UG students, aged approximately 20, struggle to perceive complex system thinking because they have not yet developed a critical 'self-authoring mind' – see section 2.4.9. A self-authoring mind is a mind that i) does not rely on, and is not primarily driven by the norms (i.e., belief, rules, and actions) of external influences, ii) is able to fully appreciate the simultaneous existence (and importance) of multiple independent yet interacting system world views – that two people can agree to disagree - and iii) that appreciates the impacts and interplay that exists within and between different systems when system norms misalign. As such I determined to critically assess i) understand deficiencies in UG student understanding of current models, and ii) to consider the development of a holistic systems model to support the teaching of key information system concepts to pre-experience students. Instead of using a different model to teach separate IS ideas, it was the aim of this research to develop a single holistic model that allowed a range of IS concepts to be constructively and systematically presented to students; allowing students to focus on assimilation of concepts rather than on the learning of multiple model ontologies.

Two research questions (i.e., RQ1 and RQ2) were developed: RQ1 - "Do MM258 students understand the systems models currently being taught to them?" and RQ2) - "Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?". To achieve these aims, four research objectives were defined: i) Conduct a systematic literature review to understand current thinking in system, education, and information systems education; ii) Design, develop, and undertake data collection to collect data concerning pre-experience management students understand of a number of current information system models; iii) Analyse collected data to a) evaluate what students perceive when considering information system models, and b) determine a kernel theory (which students do understand) that can be used as the base for development of a single holistic information systems model; and iv) iteratively develop a unified model, that is a) simple enough to be used in UG teaching, b) structured enough to incorporate a range of key literature, and c) extensible to allow future development.

Within PART 1, addresses research objective 1, and provides a justification of i) the research problem (chapter 2), by considering literature, and ii) considering the range of research methodologies (chapter 3) that could be used in this research. Literature showed that i) appreciation of complex system and system-of-systems requires a self-authored mind (Keegan, 1982), yet ii) that the majority of 18-20 pre-experience undergraduates will not possess this self-authoring mind (with only approximately 35% of adults developing this way of thinking). A pragmatic research paradigm was adopted as an umbrella in this research, however, to answer RQ1, in part two of this thesis, a deductive research approach was be used to determine empirical facts, however abduction was used in the creation of conclusions where facts are in question. To answer Q2 I used an abductively research approach to develop a holist system model, based on logical and systematic reasoning, to support the teaching of complex system thinking to pre-experience UG students. To answer Q1 the research applied a qualitative research methodology to support capture of empirical data. To answer Q2 I used design science as a methodology, i.e., as a structure to support iterative development of step-by-step artefacts that progressively incorporate and address several issues and problems. To address RQ1 I used a survey methodology, and captured survey developed to collect data from MM258 students as part of taught seminar sessions. To address RQ2 I used the Vaishnavi and Kuechler (2004) mode of design science, which consists of five iterative steps – i.e., awareness of the problem, ii) suggestion, iii) development, iv) evaluation, and v) conclusion steps.

Within Part 2 of this thesis, I considered RQ1 (and research objectives 2 and 3) by quantitatively collecting data assessing MM258 student understanding of the system models. Three existing IS models were considering – i.e. 1) Nadee et al. (2017) dual aspect model which introduces students to the idea of business norms and norm conflict, 2) Venkatesh et al.'s (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex dependency model considering technology system acceptance, and

3) Pankratz and Basten's (2013), which introduces students to a range of model of differing type and complexity. Analysis of data concerning the Nadee et al.'s (2017) model showed that students were seemingly able to understand norm conflict within systems, and technical alignment of systems. The EFA for formal alignment loaded as expected (see figure 4.19), yet the reliability of data (i.e., the KMO) was sadly low. Since students appeared able to appreciate basic norm-based models, the research concluded that the dual aspect model could be used as the Kernel model within the design science research process. Analysis of data concerning the UTAUT2 model showed that students understand the model, however I found it to be very overly rigid – e.g., use with individuals not groups, and successful load only if you use a specific set of pre-defined questions that limit flexibility in the consideration of 'additional' factors, which suggests that use of a fixed structure model as the Kernel theory for the design science research process is impractical. Although those students appreciate these models, the models themselves are not flexible enough to represent the complexity if issues that occur at a systems level (Kegan's level 4 – self-directed thinking), which requires the ability for different systems to have different perspectives and/or different structures. Analysis of the data concerning Pankratz and Basten showed that students do not appear to appreciate the granularity of specific categories, instead identifying three key phases, i.e., i) planning, 2) implementing, and iii) other project factors. This simplified model aligns well with the software development life cycle and suggests that students are better able to appreciate information systems implementation by considering explicit phases and steps, rather than interaction. Teaching an overly complex model in seminars seems to impact student understanding. As such, the Pankratz and Basten model is not effective as a kernel model for use in the design science research process.

Although limitations were identified in the collection of data, due to data being captured within a real-world teaching environment, I believe that the data was sufficient to support critical consideration of student understanding of each model of the three models, and therefore proposed the dual-aspect model by Nadee et. al (2017) as the kernel theory for use in design science research adaptation (i.e., Artefact 1).

Within Part 3 of the thesis, I considered RQ2 (and objective 4) by : i) re-considering the layout of Why, How, and What (in artefact 2 in section 5.2), ii) adding system goals and consideration of external influences (in artefact 3 in section 5.3), iii) adding an inner world model (see artefact 4 in section 5.4), iv) the handling of norm conflict (in artefact 5 in section 5.5), v) consideration of the IPO model (in artefact 6 – see section 6.2), vi) explicit consideration of behaviour and reaction (in artefact 7 in section 6.3), vii) inclusion of emotion (in artefact 8 in section 6.4), and finally addition of motivation, morals, and extensibility (in artefact 9 in section 6.5).

In artefact 2 I removed use of concentric dependant circles, thus supporting the direct interaction of all norms. This does not remove the problem of how goals are created, yet does support the direct connection between concept norms (i.e., goals) and other normal structures (i.e., informal, formal, and technical). Moreover, artefact 2 connections better represent the structure equation model results presented in Nadee et al. (2017), and support consideration of the interplay of three types of conflict (inter – between norms in different systems, intra – between different norm types in the same system, and inner – between different norms of the same type in the same system). In artefact 3, I consider that a system might have many goals, and that goals might be in conflict. A direct connection was added between the external world and concept norm structure, and the concept of memes was introduced as a mechanism to consider cultural information and social influence. The research stated that all goals should consider the KPI and should focus on change in specific object attribute variables. Consideration of belief and believability were also highlighted as important norm metadata that is needed to support comparison of norm values. Interestingly, discussion of object attribute values raised the question – Where does the system store norms? Accordingly in artefact 4 I suggest the addition of an inner world model – i.e., between the system boundary and the reasoning layer. When specific norms are taken from decomposed memes, they pass by the model on the way to being critically considered (in the norm structures). If norms already exist, then no additional norms need to be added, yet the belief and/or believability norm meta data may be adjusted. If, however, a new norm is identified, then this can be added to the inner world model; and any new objects, object instance, attributes, values, relationships are added to the model to ensure effective management of the new norm. If a new norm conflicts with other norms (either inter, intra, or inner) then some form of dissonance resolution is required. Belief and believability metadata do not change the norm structure but augment it with additional information. Artefact 5 considered how to manage dissonance resolution. I suggested a possible mechanism, adapted from the 3D_RAB model originally proposed by Wiafe et al. (2011), which allows current and new norms to be critically considered in light of the i) Current Norm (CN) - stored in norm structure, ii) New Norm (NN) - stored in norm structure, iii) Target Norms (TN) - stored in concept norm structure - with specific consideration of the norm KPI and trigger value, iv) System Attitude to Target Norm (ATTN) - stored as meta-data in 'inner world model', and v) The Attitude towards Change of poor behaviour or Maintenance of good

Behaviour (ATCMB) stored as meta-data in the 'inner world model'. The proposed mechanism dynamically determines a dissonance score outcome based on target norm definition, attitude significance (ATCMB_gap and ATTN_gap), and norm belief and believability; yet dependent on the existence of the inner-world model and meta-data relating to system attitudes. I suggested use of the adapted 3D-RAB model in all norm structures, to manage the minimisation of dissonance. The evaluation at the end of chapter 5 showed that although many issues had been effectively addressed, artefact 5 did not achieve satisfaction, since issues concerning interaction complexity, use behaviour, Habit, and Hedonic motivation needed to be considered explicitly. In artefact 6, an IPO wrapper was added to significantly reduce the level of complexity in the interaction between different systems. Having a single input and output not only allows a simplified interaction between systems but gives educators the opportunity to discuss the implications that input channel and perception has on ability of an individual to undertake effective processes. Moreover, it pushes the point that a system's world model may be significantly affected by perceptual ability, information assimilation, and interpretation. In artefact 7 I i) added an explicit behaviour layer to the artefact model, and ii) added relevant links between a) perception process layer, b) the system behaviour layer, c) the inner world model, and d) the reasoning layer, i.e., to represent different forms of unconscious reactions, observation, habit / intuition / heuristics, the act of reasoning (composed of assimilation and reconstruction links), and the act of confirming (composed of reacting and reflecting links) - identified in literature and critical to support of teaching information systems. In artefact 8 I propose linking emotional metadata, based on an adapted version of Plutchik's wheel of emotion to specific norms in the inner world model. Adding emotional metadata will allow consideration of emotion types and intensity. With this information the holistic model would be able to identify and link the norm to at least one of 48 different emotions, which supports consideration of hedonic motivation; critical to IS teaching. Finally in artefact 9 considered the issues of motivation, morals, and extensibility. Through discussion I propose possible theories and models that could be incorporated via the augmentation of norms with metadata. Concerning motivation, the research suggested the incorporation of four models, i.e., 1) Maslow's hierarchy of needs; 2) ERG Theory; 3) Herzberg's dual factor theory, and 4) McClelland's acquire needs theory. For consideration of morals, I suggest the use of optional inclusion of six moral foundations, as proposed by Haidt et al. (2012), which are care / harm, fairness / cheating, loyalty / betrayal, authority / subversion, sanctity / degradation, and liberty / oppression. Between consideration of belief, believability, emotions, motivation, and morals, I present a model that can represent, associate, and analyse a wide range of human related factors - for conceptual, informal, formal, and technical norms. Moreover, I stated that the use of metadata facilitates extensibility, and the possible use of additional models (as may be required in the future), making artefact 9 potentially capable of being adapted for use in a wide range of domains where teaching of complex interplay of systems is a problem. In the second DSR evaluation (see section 6.2) I showed that artefact 9 achieved satisfaction. Elicited expert feedback highlighted a number of issues, but suggested that the model would be understandable to UG IS student if enough time and examples were developed. Since the model has satisfied both functional evaluation, and was positively reviewed by experts, I feel confident that the final holistic model (see figure 6.17) can support the teaching of complex system thinking to pre-experience UG students, and therefore positively addresses the second research question.

7.3. Main Contributions

In this section the research will critically consider the main contributions of this work. To do this I has decomposed consideration into theoretical, methodological, and practical.

The first theoretical contribution relates to the analysis of taught IS models - i.e., 1) Nadee et al.'s (2017) dual aspect model which introduces students to the idea of business norms and norm conflict, 2) Venkatesh, Thong, and Xu's (2012) extended unified theory of acceptance and use of technology (UTAUT2) model, which introduces students to a more complex dependency model considering technology system acceptance, and 3) Pankratz and Basten (2013). Despite some minor problems, most students do seem to understand the dual aspect model. High appreciation of norm-based models aligns well with Robert Kegan's Level 3 thinking (i.e., the socialised mind), which relates to the formation and management of clear and explicit rules. Although there are limitations to norm-based models, their use should be encouraged due their ease of use and flexibility. It appears, when considering student understanding of the UTAUT2 model, that students do understand fixed models, yet struggle to appreciate that the context of use is bound explicitly to the reliability of the model structure. Interestingly this finding supports my anecdotal experience of supervising undergraduate and MSc projects, where student often try to use fixed model beyond its contextual scope of use. Concerning Pankratz and Basten, it seems that students struggle to understand the Pankratz and Basten model. Although it is not possible to be clear from our findings whether this is due to i) the complexity of the model - i.e., that the model is mapping 54 failure factors to 10 categories, 8 dimension, and multiples stakeholders, or ii) the fact that teaching complex models – such as the Pankratz and Basten model - is difficult within the limited time scale of an average seminar session. Irrespective of the reason, the DBA has shown, using empirical data, that complicated and complex models should ideally be avoided in undergraduate teaching, since such models can lead to significant misunderstanding in the minds of students.

The second theoretical contribution of this DBA relates to the creation of 8 separate artefacts, i.e., artefacts 2 to 9, and the systematic evolution of the dual-aspect model structure into artefact 9 (as presented in chapter 5 and 6) resulting in, but not limited to:

1) Development of the adapted 3d-RAB model – including the introduction to belief and believability: Although the 3d-RAB model already existed, for consideration in the area of persuasion, the adaption of this model to allow critical comparison between current and new norms (in context of the attitude to the target norm, consideration of the target KPI, attitude to positive change, and belief and believability) provides a simple, teachable, yet hugely powerful mechanism for determining the best norm. Control of the mechanism, via consideration of ATCMB_gap and ATTN_gap also allows the system to apply weightings as deemed most appropriate (over time). This mechanism could certainly be automated and would be relevant (if relevant data were available) in several domains where simple decision making is made, e.g., financial trading.
2) Definition of the four layers (perception, behaviour, inner world model, and reasoning) in artefact 7 and creation of interaction links: The creation of layers occurred over time, yet the interaction of these layers aligned shockingly well with literature (discussed in artefact 7) concerning automatic and conscious behaviour, intuition, habits, learning and reflection. In chapter 2, I introduced learning models that suggested that learning required i) reflection and iteration (Kolb), ii) consideration of logical-slow and random-quick processing (Gregoric), iii) that the world model is developed by step-by-step constructivist processes and that every world view is different (Piaget), that learning channel preference and physical ability will impact learning (VARK), that learning will include different forms, e.g. motivation / values / skills (Lewin), that learning is impacted by context and social influence (Lewin), and that a large proportion of thinking is processed by automatic heuristics (Keegan). All of these points are covered in consideration of unconscious reactions, observation, habit / intuition/ heuristics, the act of reasoning (composed of assimilation and reconstruction links), and the act of confirming (composed of reacting and reflecting links). The interaction between model layers, as demonstrated in figure 6.9, is simple, teachable, but incorporates (at an abstracted level) much of the learning and psychological ideas that appear in literature.

3) Consideration of how to adapt and use emotion, motivation, and moral metadata: the use of additional metadata to represent belief, believability, emotion, motivation, and morals – and also to support extensibility – provides the final artefact (see figure 6.17) with the ability to link modelled norms to specific human factors. By combining of Plutchik's emotional model and wheel of emotion the final model is not only able to consider emotion intensity (24 possible emotions of different intensity), but use of dyads (primary, secondary, and tertiary) also allows consideration of mixed emotions (24 extra possible emotions). With limited capture of metadata, the model is therefore able to consider 48 emotions. Moreover, consideration of all motivation models allows consideration of a wider range of motivations that would have been possible using only a single solution.

7.4. Limitations and Suggested Directions for Future Research

There are many issues and problems in this research, some of which I will expounded in more detail in the personal reflection section (see section 7.5). In this section I will consider three issues:

1) Although the model passed the DRS evaluation, the model has not been validated as useful in a real-world teaching space. Although this was my original intention (i.e., in the 19-20 and 20-21 cohorts), the covid-19 pandemic prevented development and delivery of face-to-face sessions. Although it might have been possible to conduct an online session, I decided that this would be difficult due to too many confounding variables. Throughout covid my workload doubled, and the idea of adding the development of a new set of MM258 seminar sessions seemed too much. Accordingly, the model is evaluated yet untested.
2) Although the model has been developed to support the teaching of generic information systems concepts to UG pre-experienced students, and although I am confident that the model should support consideration of most IS topics, some mapping will be required to interpret how issues can be modelled. This interpretation, e.g., identification and allocation of key example norms, etc. will require interpretation by the educator. Although this interpretation allows the model to be adapted to several uses, there is considerable scope for misunderstanding.
3) The research, as will be expanded in the personal reflection, faced considerable initial data access problems, which resulted in the significant reshaping of the problem. This delay impacted the time left in registration to conduct the research (including extensive capture of data of two years) and writing of the thesis. These initial problems put considerable pressure on the design and development of the seminars, which in turn resulted in the

collection of data, which (although acceptable) is arguably but far from ideal. This is a slight disappointment, though much was learnt in the process. Although data was sufficient to support selection of artefact 1, additional time spent on design of data may have led to results that could have been disseminated more widely.

7.5. Personal Reflection

Recent DBA thesis that I have read, and occasionally PhDs, have included a section concerning researcher reflection; i.e. a section concerning personal reflection to allow the researcher to openly express his/her thoughts concerning steps in the doctoral research journey. As a reader, I've often found this section very interesting, and useful, since it gave me the opportunity to appreciate what he/she thinks (in retrospect) about some of the decisions made.

If this is of no interest to you, then please feel free to skip this section!

For those that read-on I hope that this section will provide me the opportunity to express to the reader - with the beautiful appreciation of hindsight - what I really learnt and what I should have done better.

7.5.1. Motivation

On numerous occasions, I reflected why I decided to start this endeavour - as I had no professional need to obtain a second doctorate degree. When I started this DBA, most of my research time was dedicated to the support of others. As such my reading and focus was split significantly between the supervision of numerous PhD projects, and a range of different information system / informatics related domains, including innovation, persuasive technologies, health informatics, etc. In addition, I found myself getting involved in the research of numerous colleagues, yet in domains as diverse as cognitive neuroscience, multimedia perception, and organisational semiotics - some of this work is referenced in this thesis.

My personal motivation in starting this DBA, in addition to answering a practical problem related to the MM258 module, related strongly to the personal desire to take back control in my research, i.e., i) to identify the scope of research that I wanted to focus on, and ii) take back ownership of some significant parts of my research activity. I believe that doing the DBA has supported this desire.

7.5.2. Research Questions, Aims, and Objectives

Although the research question, aim and objectives presented in this thesis are hopefully a clear outcome of logical reasoning, the original DBA idea related to the area of health informatics; and the desire to understand what caused failure in the domain of health. It soon became apparent, however, upon reading around the area of health information systems failure, that extensive work had been done in this area. Moreover, when I spoke to health stakeholders, it became obvious that the data required to undertake an assessment of health systems failure was practically impossible for me to acquire due to the nature of health-related data.

The problem of failure, however, was rooted in my head! Why was it that projects kept failing, even though such a significant amount of information about information systems failure was available in the literature? The people that I spoke to, especially within health information system implementation teams, all seemingly possessed relevant IS qualifications, so why did IS failure keep happening?

It occurred to me after about two years of doing the DBA, that i) I needed to change the research focus, as my access to data, despite considerable efforts, was extremely limited, and ii) interestingly the same issues occurred in numerous domains, which logically suggested that failures in health was being impacted by a bigger issue related maybe the attitudes (biases), thinking, or education of IS project stakeholders.

Since I worked at a university, and was teaching an undergraduate module to business, management, and accounting students, it seemed a viable suggestion to assess whether undergraduate student truly understand the complexities of information systems and information systems failure. Although I had included discussion of information systems failure within the M258 course for many years, in the 2015 cohort I included an explicit seminar session that introduced discussion about the Pankratz and Basten (2013) paper (see section 4.2.3). Interestingly, this session resulted in some students becoming quite confused by the fluid definition of failure being presented - ‘surely success or failure was explicit – i.e., success or failure’. Although many students got it instantly, many struggled with the paradox that an information systems project could be both a success and a failure at the same time - i.e., that the perception of outcome was not black or white but impacted by different stakeholders’ horizon (beliefs, experience, and attitude) and that the stakeholder defined success. If you were the finance director, then a failure would be defined by going over budget. If you were the project manager, then the project would be a failure if you went overtime. If you are a customer, then the project would be a failure if key requirements were not met. When you looked at case examples of failure, the project was often driven by a few stakeholders, who held very different perceptions concerning the concept of what defined project success yet manipulated project factors to achieve satisfaction of their own interests whilst ignoring the failure perception and concept of other stakeholders.

The fact that some students struggled to appreciate intangible / subjective topics was very interesting to me. Moreover, once I had questioned the inability of some students to appreciate complex systems ideas, I started to see the same problem everywhere – and the foundation of this DBA was formed.

The problem of perception is something that is not easily 'fixed' by using an implementation guideline or framework. The problem of student perception and learning is also interesting as the issues are potentially different for each person – making it extremely hard to consider and/or manage. Accordingly, after about 3 years of part-time study on the DBA, and after considerable reading of literature, the issue of individual perception and learning in the domain of IS came into focus. In the 3rd year DBA annual presentation, the amazing Prof. Jane McKensie rightly told me that I needed to go back to literature, i.e., to ground my thinking in some theoretical theory from literature. Accordingly, only after another year of teaching MM258, and reading education and psychological literature, did the thesis problem, aim and objectives (as defined in this thesis) truly emerge.

Einstein is quoted as having said, "If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions." In this thesis, the process of reading about, and defining the problem, took a large proportion of the research time. As such the contribution of this thesis, potentially has a more significant scope then would have been possible if health data had been easily available. Only after considerable reading - in several areas of research - including psychology, learning and education literature, organisational semiotics, biology, holistic thinking, etc. was I able to appreciate that several issues I found in IS linked closely to descriptions in other areas. Echoes of similarity, existed in several domains, which reminded me of figure 7.1, and although specific domains may use their own language, methods, and tools, I started to believe that development of a more generic holist IS model might be possible.

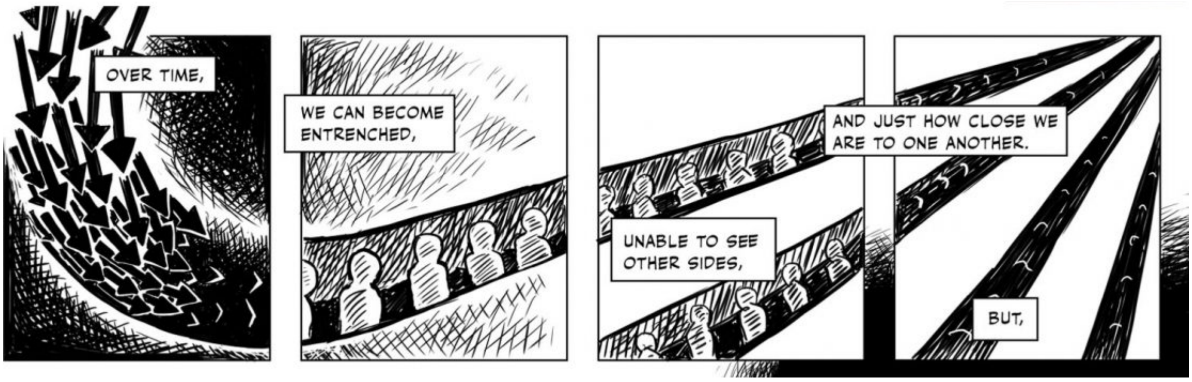


Figure 7.1. Research domains sometimes seem isolated (adapted from Sousanis, 2015).

7.5.3. Consideration of Methodology

I personally learnt a lot about use of methodology from undertaking this DBA, particularly because the issue of data access had a significant impact on both the scoping of the problem, but also on the quality of data that could practically be collected within the DBA; and used in chapter 4 to justify selection of the kernel theory (i.e., artefact 1). Even once a clear scope had been defined, the capture of data was complex – as data in part two of the thesis was primarily collected within live seminar sessions, i.e., where teaching of UG students was the primary focus (the day job) and capture of DBA data could only be achieved as a secondary activity.

PART 2 – Methodology and Data

Due to seminars being part of the MM258 module, the number of questions that could be asked in seminars was very limited. If the primary focus of the seminar had been to collect research data, then I would have captured a much richer and more extensive range of data concerning conflict, technology acceptance, and failure issues. Although the limitation in number of questions limited the number of question items used, it did ensure that question items data was collected in a real-world context. In the systems conflict seminar, data was captured about i) which IS conflict states were believed by student to be most important, and ii) about adapted KANO questions, as used in Nadee et al. (2017). I was unaware when designing the session that ranking data is not useful within statistical analysis, however the seminar required consideration of priority. In the technology acceptance seminar, a range of questions were used, to give students the chance to reflect on different aspects impacting Bandon, which was useful for module coursework. Interestingly, however, because I did not use the traditional UTAUT2 questions the loading of item questions reflected stakeholder and KPI theme constructs. In retrospect additional time should have been taken to design, test, and check the questions use in the first two seminar sessions; however, there was only a limited period (a matter of weeks) between definition of the final problem scope, and the start of the academic year. I managed to pull together the seminars and developed the online website to support feedback of data, yet additional time (in reflection), spent on development of these first two sessions, would have been ideal. Ironically, due to the session being later in the term, more time and effort was spent on the design of the Pankratz and Basten questions, despite the poor results; yet additional testing of these questions would have been ideal.

The reduced quantity, and arguably quality, of data collected in seminars certainly impacted my ability to create effective analysis models, yet (in my opinion) the seminar design, and the data collected, did allow a basic analysis of student understanding to occur. It would have been nice to spend more time on the design of these session, i.e., to develop a dataset that is more 'publishable', however i) the time available to develop the session was exceptionally limited, and ii) the primary goal of the seminars was to support the education of the students – and DBA data collection was impacted significantly by placing the students first. I could have, in retrospect, done a much better job on the design of these sessions – but retrospect is an amazing thing. The fact that I'm able to reflect retrospectively on possible improvements implies that I have certainly learned a lot about data collection.

PART 3 – Methodology

I have used DSR within several previous research projects, and have had a very mixed experience. This experience, with design science used in PART three as a methodology has been useful and informative. Unlike Hevner et al.'s methodology, which does not support step-by-step 'release' and/or use of each iterative artefact, Vaishnavi and Keuchler's five steps methodology has been very useful in the iterative development of the final artefacts. The creation of multiple iterations provided me with a clear and systematic approach to consider separate system issues. It is not perhaps essential for students to consider all iterations – i.e., as the basic flux model - artefact two - may be sufficient to facilitate discussion of an organisational merger or systems conflict.

I am very aware that the writing of thesis, which was achieved in appropriately 40 days, was motivated significantly by my reaching the end of DBA registration period. Ideally, I had hoped that I would have time, as part of the DBA, to test and validate each part of the model with the

MM258 cohort, however limitations in time, and restrictions imposed since March 2020 due to covid-19, means that a full validation of the model was not practically possible.

7.5.4. Research Question 1

Research question one asks: Do students MM258 understand the systems models currently being taught to them? To achieve research question one I defined the following three objectives:

- Conduct a systematic literature review to understand current thinking in the domain of system, education, and information systems education.
- Design, develop, and undertake data collection to collect data concerning pre-experience management students understand of several current systems models.
- Analyse collected data to i) evaluate what students perceive when considering information system models, and ii) determine a kernel theory (which students do understand) that can be used as the base for development of a single holistic information systems model.
-

A systematic literature review was provided within chapter 2, however the number of topics considered in the literature review was reduced when writing the thesis, since contextual discussion of topics seemed best place in relevant PART 3 artefact sections. The discovery of Robert Kegan's theory of adult development was a light bulb moment in the DBA. Not only did it provide the theoretical foundation to the problem, which Prof. Jane McKensie had requested, but also removed and amount of the guilt that I felt that some of my students were unable to fully understand the complexity of systems interaction discussed in MM258. As someone prone to intruder syndrome, the fact that Kegan suggested that student confusion might not be due to pedagogy use was refreshing. Instead of assuming the students can assimilate the information if the right approach is used, Kegan's theory of adult development changes the question to - Why are students unable to assimilate the information if an effective approach is provided? The question is no longer about blaming the teacher, but instead has transformed to a question about understanding the perception of the student – which is a positive shift and one that I think more accurately frames the core problem.

Reflection concerning the second objective, i.e., to design develop and collect data relating to the pre-experience undergraduate student, was largely considered within the discussion of methodology. In summary, the design of the data collection process was slightly rushed, and in retrospect I could have done better in the design and development of system conflict and technology acceptance seminars to ensure collection of more extensive, and higher quality, data. I potentially lost out on publication quality data, and the development of several interesting models, however I am personally happy that the data collected served the intended purpose.

Analysis of the collected data, as stated above, would have been much more substantial if I had had, throughout the seminar planning stage, my current knowledge of stats. Although I still have a lot of learn in the domain of quantitative analysis, undertaking this DBA has taught me a lot. Further study in this area is certainly high on my to-do list, as I think that additional appreciation of analysis tools would strengthen my ability to better design mixed-modal research. Although higher model reliability would have been good, results do suggest that UG students do appreciate the dual-aspect model, and the technology acceptance model (though assessment of concepts is significantly impacted by the wording of question items), however students do not appreciate the complexity of the Pankratz and Basten model. This result satisfies both parts of object 3, and I am personally confident the selection of the dual-aspect model (which is simple but flexible) was the correct kernel theory for use in the design science research artefact development.

Artefact 1

Artefact 1, i.e., the dual-aspect model, was first developed by Winai Nadee, as part of his PhD research. As his PhD supervisor, I was significantly involved in the discussion and development of the dual-aspect model, and the subsequent publication of the model (in part to be able to consider it formally as part of this DBA). Although artefact one, i.e., the dual-aspect model, provided a simplified version of the data that created it, the use of norms and norm layers (concept, informal, formal, technical) provided a model that student understood (as evidenced in chapter 4). The placement of the technical layer as the outer concentric circle, like that of Edward Hall, means that the dual aspect model - unlike many other similar models - could be used to compare and consider the interaction of multiple different types of systems (i.e., organisational, human, technical), which supports critical consideration of the interactions of humans and technology, technology and organisations, management style and organisational structures, etc. Unlike fixed models, such as UTAUT2 and the Pankratz and Basten model, which are designed to present information about a specific topic, the dual aspect model provides a generically applicable solution, which offers considerable benefits when teaching a range of topics. In my experience, the dual-aspect model is most simple to explain to students and can be applied in a more considerable range of contexts and subject domains. As such I was pleased, but not surprised, by the results identified in chapter 4.

7.5.5. Research Question 2

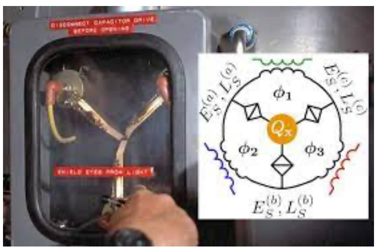
Research Question two asks: “Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?”

To achieve research question two I defined the following objective:

- Iteratively develop a unified model, which is i) simple enough to be used with UG teaching, ii) structured enough to incorporate a range of key literature, and iii) extensible to allow future development.

Artefact 2

Although Winai Nadee was primary responsible for development of the dual-aspect model, it never sat well with me that the final model outcome, although better then Edward Hall’s Major Triad (see figure 4.1) and Stamper's onion (see figure 4.3) at considering complex information systems issues, did not i) represent the direct link between the technology layer and the informal layer, ii) consider how alignment and change occurred between layers, and iii) consider how the conceptual layer norms were formed. Although not all of these issues were solved in artefact 2, the reshaping of the dependency relationships between norm structures means that all points can now talk to all points. The solution came to me in the middle of the night and woke me up, and like Doc Brown’s discovery of the flux capacitor in back to the future (see figure 7.2a) I had to find a pen and draw it down. Accordingly, I named the core of the artefact, which remained unchanged throughout, the basic flux model (see figure 7.2b).

a) 

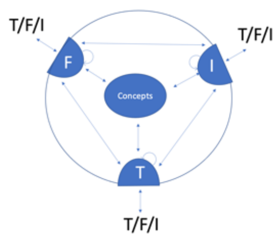
b) 

Figure 7.2. a) Flux Capacitor from ‘Back to the Future’ and b) Basic Flux Model.

I was so pleased that the solution addressed several of the problems with the dual-aspect model, but it also resulted in some interesting discussion concerning the direction of influence, and the flux that might occur in system norms as a result of external influence and internal alignment.

Artefact 3

In artefact 3 I added the idea of social memes, which was inferred from Hofstede's onion model of culture (see figure 5.7). I remember seeing Hofstede's onion of culture and wondering as to the mechanisms that would make this work. The issue of flow and/or consideration of how particular norms were learned, propagated, and updated in the cultural model was something that Winai Nadee had struggled with, however had decided to define as beyond the scope of his research question. Winai was possibly right in the scoping of his thesis, but it left the problem frustratingly unsolved.

The solution of using Dawkin's memes (a unit of cultural information spread by imitation) fitted perfectly with Hofstede's work. A simple direct connection to the concept layer, i.e., to adjust the focus of reasoning via a change in goals, as a result changes in social norms, may appear reasonable simple and logical, but it incorporates the work of numerous researchers, and provides an eloquent and simple solution to explain how all norms, including conceptual norms, can be updated directly by the surrounding environment. As well as supporting discussion about 'what is culture', nature / nurture learning development, and social and cultural influence, it facilitates students in consideration that context is significant to the definition of goals. I am proud of this simple coming together of theory, as it also specifically confirms that a system 'why' is core to all other drives.

Artefact 4

In artefact 4 I added the concept of the 'inner world model'. Although this seems logical in retrospect, the idea that each system should explicitly store information about the system world view, is not something that I have seen in many other models. The idea that each complex system has a different view of the world, and that this 'horizon' impacts how information is assimilated, processed, and disseminated is very interesting to me.

I purposely avoided a discussion of 'how' the world view could be implemented practically, and/or 'what' technologies should be used to implement the solution, however it seems clear in reflection that although many technologies exist to solve part of the problem, a real-world prototype would need to bring together many theories and approaches, e.g., object-orientated theory, object-attribute value and relationship databases, metadata tagging, etc. I still have several issues and questions relating to how an inner world model might be technically developed, however these issues lay outside the scope of this project. Further consideration of this would be interesting as part of a future PhD - though I won't be doing that one!

I feel that the need for an 'inner world model' is critically important, and strongly believe that student appreciation helps them to develop a better awareness of i) their own perception of reality, and ii) a fuller appreciation that perception of reality is different for all, which is critical to Level 3 thinkers progressing towards level 4.

Artefact 5

In artefact 5 I addressed the issue of norm conflict management, i.e., between different systems (inter conflict), between different types of norms (intra conflict), and between different norms of the same type (inner conflict). although the idea of non-conflict was introduced within artefact 2, no resolution to the problem had been proposed earlier in the thesis. The solution adapted in the thesis incorporates the 3D-RAB, which was developed by Isaac Wiafe to solve the problem of dissonance in the domain of persuasive technologies. Introduction and consideration of cognitive dissonance works well with the idea that systems are constantly resolving and re-resolving conflict. In context of business, the idea of external influence, and transformation and change, or all issues which highlight the need to consider the issues of dissonance and change.

Incorporating, yet adapting, the 3D_RAB model is an interesting addition to this thesis, as it provides a relatively simple solution that balances well the needs to i) produce a quantifiable outcome, ii) be flexible enough to support cross norm conflict, and iii) incorporate subject human factors, such as belief and believability. The use of a target norm KPI norm seem resolves several issues and aligns well with the earlier statement that all norms need to be dependent on the 'why' – i.e., the concept norms. I hope to develop and publish this idea further.

Artefact 6

In retrospect, I believe that consideration of the IPO model – especially for technology focused students – might be better incorporated as an earlier artefact, since the introduction of the IPO model is often the first, most simple, information system model presented to students as is the case in this thesis (see section 2.1). Incorporation of the IPO model at an earlier point would not result in a significant adaptation of earlier iterations (see figure 7.3 for possible revised version artefact 3, 4, 5; i.e., R3, R4, and R5). Practically, however, the order of artefact evolution is somewhat unimportant; as artefacts 6, 7, 8, and 9 would remain unchanged – and the proposed change is not significant in content or intention.

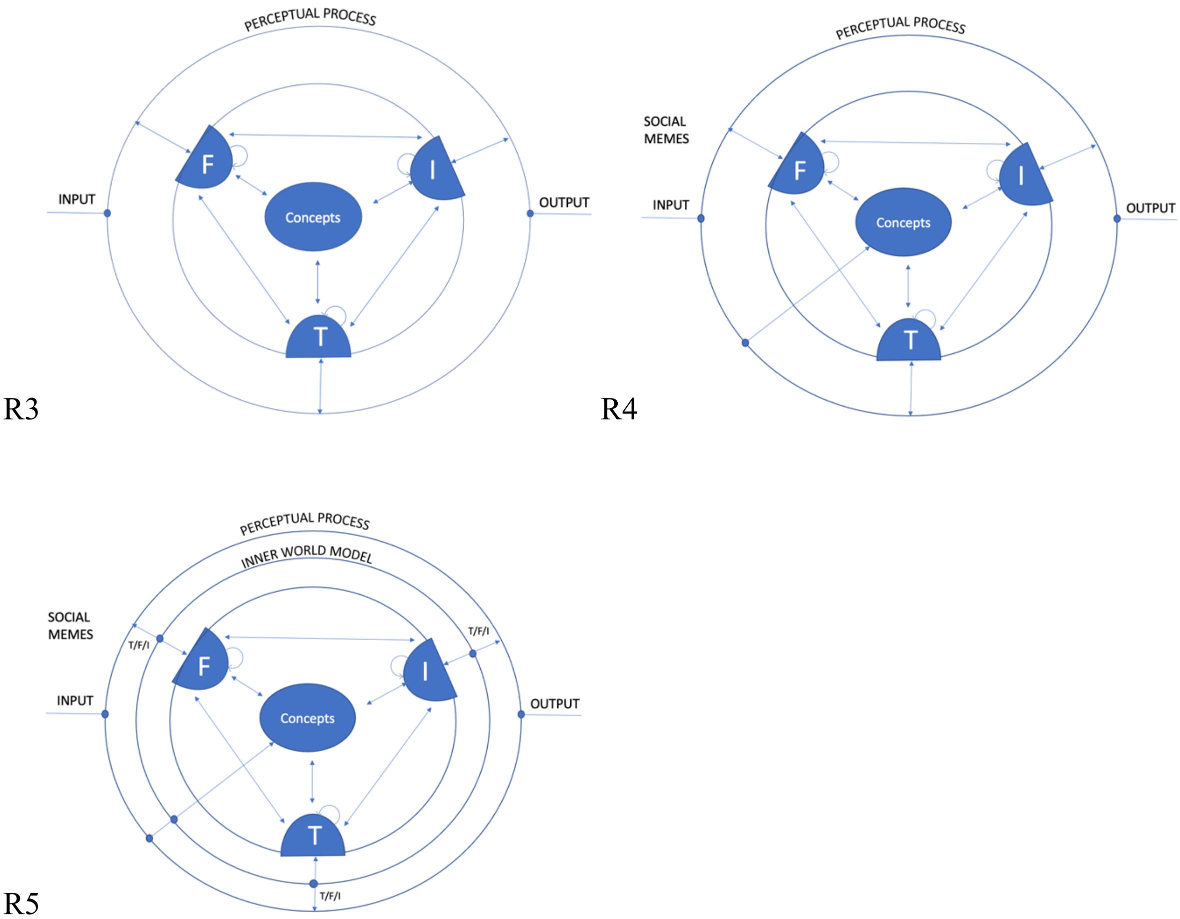


Figure 7.3. Proposed revision to A3 A4 A5 support teaching order.

Irrespective of the order, consideration of the IPO model provides a clear system boundary, allows explicitly discussion of requirements, and inherent system perception. Although some might question whether a clear boundary is always possible, the discussion concerning difference in information assimilation between systems would be interesting. Moreover, the IPO model aligns well with consideration of requirements analysis, which would certainly make the model more useable for industry-based development teams.

Artefact 7

Artefact 7 considers a number of behavioural and communication issues. Once the inner-world model, reasoning (3D-RAB), perception, and behaviour structures were in place (respectively introduced in artefacts 4, 5, 6, and 7) it was fascinating to see what behavioural functionality could be created by looking at the interaction between different layers (see figure 7.3).

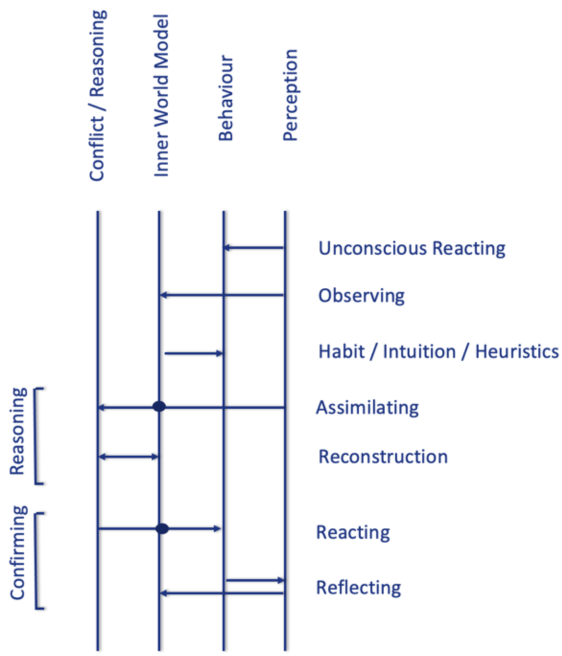


Figure 7.3. Artefact 7 – Reaction and Behaviour.

I was personally surprised, and proud, that the interaction of these four simple layers (see figure 7.3) was able to represent so many of the different behaviour and communication concepts, e.g., automatic unconscious reaction, habit, intuition, conscious reasoning and reaction, and learning (including observation, and reflection). Although figure 7.3 represents an extremely simplified model of reaction and behaviour, having a simple tool (i.e., four lines representing perception, behaviour, inner world model, and reasoning) that facilitates critical discussion in this area is extremely useful. I hope to develop and publish this idea further.

Artefact 8 and Artefact 9

Although they are presented and considered separately, Artefacts 8 and 9 were developed at the same point in time, due to the need to include human factors via consideration of additional meta-data. Although the first DSR evaluation highlighted a need to incorporate joy, I was surprised the range of possible emotions that could be expressed in artefact 8 by the adaptation of Plutchik’s wheel of emotion provides. Inclusion of emotion, via use of this mechanism, is of increasing important to Information Systems and business, and I hope to develop and publish this mechanism further in the future. In the area of motivation Maslow’s hierarchy of need is often used without thought, however my research identified numerous possible models (four of which were used – see section 6.5.2). By using different models, a range of motivation factors were considered, which again was far more extensive than I had originally believed possible.

This flexibility resulted in the suggested (expanded in section 6.3.3) that there is no reason why the user of the holistic information system model could not incorporate a whole range of additional factors and variables by incorporating relevant metadata tags. I remember looking at the work of Ken Wilber, feeling lost as to how a single model might try to incorporate all the ideas, yet in retrospect it's clear that the model doesn't have to incorporate everything, but able to facilitate a flexible and extensible use which can be adapted as required in context of the application. I believe that the holistic information system model could be used in domains including sociology and psychology, religion, and history, I'm intrigued to see whether adaptation into more abstract domain means is possible. I hope to develop and publish this idea further.

7.5.6. Personal Reflection Conclusion

I've never enjoyed writing conclusions, as the work always continues. Although the DBA was sometimes rushed, due in part to personal and professional responsibilities, in reflection it has allowed me to refocus my interests and research and has prevented me from getting stuck in a rut too early in my career. For the past x years (x because I honestly can't remember how long I've been doing the DBA for) I've always known that I need to make progress on the DBA as it wasn't going away unless I completed it. Although it did at times feel like an albatross, it meant my research was never totally neglected when other pressures grew. The DBA, especially throughout the pandemic, ironically became a retreat of sanity, where I retreated to learn from the fields of psychology, biology, educational research, philosophy, systems research, etc…. I've certainly read a lot of books and papers in the past few years (most of which is not included in this thesis).

It would've been exceptionally easy to just continue supporting others in their research, but I see now that some of these projects were useful in solving specific pieces of a larger puzzle, which I believe I have started to uncover in the DBA. Of course, there is much work to be done moving forward, but I'm proud to the artefact 9 model, and believe it has considerable value, which I look forward to realising more widely – e.g., actualising this in class teaching, and validating the value across a range of domains.

7.6. Thesis Conclusion

The literature showed that it was critical to assess how pre-experience students perceive of a range of IS model, to i) understand deficiencies in understanding, and ii) to allow the development of a holistic systems model to support the teaching of key information systems concepts to pre-experience students. Accordingly, two research questions (i.e., RQ1 and RQ2) were developed: RQ1 - “Do MM258 students understand the systems models currently being taught to them?” and RQ2 - “Can a holistic systems model be developed to support the teaching of complex system thinking to pre-experience UG students?”.

I have achieved RQ1) in part 2 of the thesis, and RQ3) in part 3 of the thesis. Although there are things that could (perhaps should) have been improved (in retrospect), I believe that both research questions have been systematically considered using relevant research methodologies. The final artefact 9 (see figure 6.17), though still quite simple in appearance, the model incorporates consideration of an extensive number of ideas and concept. Within the DSR evaluation, I have shown that, within the single model, artefact 9 can consider all issues covered previously by dual-aspect, UTAUT2, and (as far as can be assessed) Pankratz and Basten. Although practical validation is still required, I am confident that the research questions have been addressed and the final artefact, and associated mechanisms and ideas, provide a significant contribution in the domain. I hope the reader agrees!

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A1. Pankratz and Basten (2013)

Table A1. Journals used for Case Analysis (Pankratz and Basten, 2013).

Journal	Searched period
Communication of the ACM	1958 - 2012
Communications of the Association for Information Systems	1999 - 2012
European Journal of Information Systems	1991 - 2012
IEEE Software	1984 - 2012
IEEE Transaction on Software Engineering	1976 - 2012
Information & Management	1977 - 2012
Information Systems Journal	1991 - 2012
Information Systems Research	1990 - 2012
International Journal of Project Management	1983 - 2012
Journal of Information Technology	1986 - 2012
Journal of Management Information Systems	1984 - 2012
Journal of Strategic Information Systems	1991 - 2012
Journal of Systems and Software	1979 - 2012
Journal of the ACM	1954 - 2012
Journal of the Association for Information Systems	2000 - 2012
Management Science	1954 - 2012
MIS Quarterly	1977 - 2012
Project Management Journal	1997 - 2012

Table A2. Identified IS Project Stakeholders (Pankratz and Basten, 2013).

Stakeholder	Definition	Stakeholder Abbreviation
End-users	Those who will operate the developed system. Often a heterogeneous group of people with different roles and requirements	EU
Sponsor	Person or group that champions and provides resources for the project. This includes gathering support throughout the organisation, promoting project benefits, leading project through engagement or selection process until authorization, playing a key role in development of initial scope, serving as escalation path for issues beyond project manager's control etc.	Spo
Top management	Top management of the customer organisation, that is, the organisation that commissioned the product	TM
Customer	In contrast to more concrete roles defined above, this group comprises all members of the customer organisation affected by the project	Cus
Contractor	All members of the contractor organisation affected by the project	Con
Requirements specialists	Responsible for collecting customer requirements. Requirements specialists also mediate between the domain of users and the technical world of engineers	RS
Software engineers	Responsible for designing and implementing the IS	SE
Testers	Test team that can be composed of internal and/or external members, the latter to add an unbiased, independent perspective	Tes
Portfolio / program management	Organisational entity or individual(s) responsible for the high-level governance of a collection of projects or programs (on program level, for managing related projects in a coordinated way)	PPM
Project management office / project manager	Organisational entity or individual(s) whose responsibilities range from providing project management support functions to being responsible for direct management of a project. In charge of all aspects of the project including planning, keeping the project on track according to plan, identifying, monitoring, and responding to risk, communicating with all stakeholders, particularly the project sponsor and project team	PMO
Team members	Individuals from different groups with a specific skill set who carry out project tasks but are not necessarily involved with project management. Includes RS, SE, and Tes, but excludes PMO	Team
Suppliers	External companies making a contractual agreement to provide components or services for the project	Sup
Project	All stakeholders affected by the project (i.e., all groups above)	Pro
Regulators	Authorities regulating the domain (e.g., banking) for which the IS is developed	Reg

Table A3. Failure Dimensions.

IS project Failure Dimension			Description
Process Failure	1	Time	Schedule not met
	2	Cost	Budget is not met
	3	Quality	Specifies requirements are not fulfilled
	4	Quality of the Project Management Process	Project is not managed efficiently (e.g. inappropriate use of resource)
	5	Stakeholder Satisfaction related to process	Concerned stakeholders are not satisfied with the project management process
Product failure	6	Project Goal	Project does not support organisational strategic goals
	7	Project Purpose	Developed iOS does not satisfy real needs of the user
	8	Stakeholder Satisfaction related to product	Concerned stakeholders are not satisfied with the product

One or more abbreviated stakeholder Tags (see table A2 for expanded details), one or more failure dimension numbers (see table B3 for expanded details), and one or more literature reference source (see table B1 for details) were connected to each of the 54 factors presented in tables B4 to B12; i.e. in order to highlight which stakeholders are impacted by each of the 54 failure factors.

Conditions: This category comprises conditions present at project initiation

Table A4. Conditions: description, stakeholder involvement, failure dimensions, and source links (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
Lack of clear responsibility for IT	Lack of a single entity responsible for IT leads to objective conflicts and absence of a clear strategic vision	TM	6	5
High system complexity	The process structure to be supported by the system is highly complex, leading to a vast amount of dependencies to consider during development	Spo, PMO, SE	1,2,3	12
Climate of mistrust within customer organisation	Climate of mistrust and obstructiveness leads to conflicts, ineffective communication, anxiety, and resistance within the customer organisation, e.g., employees not accepting a system as a result of mistrust in management	Cus	4,5	5
Unclear strategic goals	Initiating a project without clearly defined customer's strategic goals	Cus, Con	6,7,8	14

Directive decisions: Key stakeholder decisions that have a significant impact on project course

Table A5. Directive Decisions: description, stakeholder involvement, failure dimensions, and source links (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
Requirements not regulated contractually	Refers to (partially) agreeing on requirements verbally rather than regulating them contractually, which often leads to unfulfilled requirements	PMO	3,5,6, 7,8	2
Lack of acceptance criteria	No formal criteria are specified for acceptance or rejection of the completed system	PMO	6,8	7
Insufficient contractor experience	Contractor's experience in developing information systems is not sufficient for the degree of complexity in the given project	TM, Spo	3	5
Prolonged contractor competition	Competition between contractors for the project is protracted too long, leading to reduced morale and delays	TM	1,3,4	1
Replacement of the contractor	Changing contractor during project leads to setbacks as new people need to be brought up to speed	TM	1	10

Insufficient consideration of customer: Comprises factors concerning the insufficient

Table A6. Insufficient consideration of the Customer: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
System does not fit culture of customer organisation	IS does not suit organisational culture, e.g., a decentralised organisation with several business units (each with its own way of thinking) implementing a centralised IS	RS, PMO	3,6,7, 8	2,8
Inappropriate development approach	Development approach is inappropriate in the given context, e.g., a development approach that requires fast and authoritative decisions applied in a culture of personal responsibility and allocating blame, leading to unwillingness to take risks and delayed decisions	Cus, PMO	1,2,4	4,7
System does not suit customer's strategic goals	Applies if customer's strategic and system objectives are not aligned or if the customer's strategic goals are inappropriate	Cus	6,7,8	6,14
Requirements discrepancies among user groups not considered	Insufficient consideration of the different needs of various user groups, e.g., different level of detail for data input of employees and managers, leading to resistance of disadvantaged groups	RS, PMO	3,6,7, 8	2
Developers lack understanding of users' needs	Developers lack professional understanding of end-users' work practice and real needs, leading to inadequate design concept and a system that is not accepted by users	Con, Spo	6,7,8	9

Project planning: Factors relating to the estimating and planning of the project

Table A7. Project planning: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
Unclear project goals	Project goals are vague and not clearly defined in the project contract, including unclear requirements	Cus, PMO	1,3,6, 7,8	11,13,14
False business case	Business case that underlies the project is false, e.g., due to underestimated personnel or operating costs	PPM, PMO	6	13
Lack of time planning	No formal project schedules including important milestones are specified	PMO	1,5,	7
Underestimation of effort	Contractor underestimates project effort, resulting in too tight schedule and budget, and provides this false information to customer, raising unattainable expectations	PMO	1, 2, 5	13
Lack of overall IS plan	Lack of an overall plan for implementation and operation of the system to achieve organisational objectives	PPM, PMO	4, 5, 7, 8	6, 7

Project management: Factors with regard to the actual management of the project after initiation

Table A8. Project Management: Description and stakeholder Involvement (Pankratz and Basten, 2013).

Factor	**Description**	**Stakeholder**	**FD**	**Source**
Inexperienced project manager	Project manager is not sufficiently experienced for the project at hand (e.g., lack of required technical skills, leadership, professional competence)	PPM	1,4	4,7
Inadequate requirements specification	Requirements documents describe in detail how requirements are to be implemented instead of the actual requirements ("how" instead of "what")	Con, Cus	3,7,8	7
Development approach not understood	Team members do not sufficiently understand the chosen development approach, leading to conflicts and inefficient use of resources	PMO, Team	4	4
Project management method applied incorrectly	Chosen project management method is not applied correctly, e.g., PRINCE prescribed but not followed by all project team members	PMO, Team	3,4,5	5
Ineffective communication	Stakeholders do not get information affecting them or needed to perform their tasks (e.g., due to communication gaps or intentional misleading)	Pro	1,3,4, 5,7,8	4,9,12,13
Loose project control	Poor project initiation and control mechanisms (feasibility study, formal reviews etc.)	Cus	4,6,7, 8	9,14
Prolonged development	Implementation is protracted very long. Leads to reduced motivation and greater chance of staff changes	Con	1,3,4	9, 14
Management forces fudging status reports	Employees are forced to adjust their status reports to formally meet a prescribed unrealistic schedule resulting in inevitable delays and frustration	PMO	1, 2, 5	13
Insufficient quality assurance	Shortcomings in system testing (e.g., due to time pressure), resulting in too many defects in the delivered system	Spo, Tes, PMO	1,3, 5, 6, 7, 8	1, 2, 5, 15

Change management: Factors related to managing change induced by the introduction of a new IS

Table A9. Change Management: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
Users lack of experience in using IT	Users are unfamiliar with information technology, resulting in discomfort and reluctance to adopt a new system	Spo, PMO, EU	7,8	3,5,6
Changes in traditional routines and practice	Users are often reluctant to use IT that changes their routines and familiar ways of work, especially if no benefits are perceived to emerge from using the system	Spo, PMO	7,8	3,6,8
Redistribution of power	Stakeholders that are negatively affected by change of power exercise resistance	Spo, PMO	7	3,8
Insufficient stakeholder involvement	Project stakeholders, especially users, are not sufficiently involved in planning, development, and deployment of the system. Important experiences are left out, developers lack essential information, and user needs are not met	Pro	1,2,3, 4,5,6, 7,8	1,4,5,8,11, 14,15
Low morale of end-users	End-users lack motivation to deploy the new information system	Cus	8	5
Inadequate training	Shortcomings in training the end-users to use the system, including insufficient training, too early training (with system changes afterwards) etc.	Spo, PMO	4,5,7 8	5,8,9,15
Limited prestige and status of project champion(s)	If project champions (being change leaders) are not well-known or lack status, e.g., when people move into new positions during the project, their influence on project stakeholders is limited	TM	8	3
Disregarding different perceptions of stakeholders	Failing to recognize that different stakeholders ascribe different meanings to the same events, e.g., if managers think that the system will help their employees, and employees consider the system a threat as it does everything they are supposed to do; leading to resistance	Spo, PMO	8	5,10
IT is considered a magic bullet	Assumption that the single introduction of the IS leads to changes in work routines and intended benefits, neglecting essential change management practices	TM, Spo, PMO	7,8	5,6

Top management attitude: Factors related to attitude of higher management towards the project

Table A10. Top Management Attitude: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	**Description**	**Stakeholder**	**FD**	**Source**
Insufficient top management commitment	Top management fails to give the required attention to the project, leading to lack of resources and decisions	TM, Spo	3,5,6, 7,8	2,6
Decision frame of key decision makers influenced by prior successes	Prior successful projects can cause responsible managers to be too confident about the current project and downplay the significance of negative information, reducing their willingness to re-examine the current course of action	TM, Spo	3,4,5, 6,7,8	8,9
Stakeholders responsible for project not open for problems / criticism	If stakeholders responsible for a project do not acknowledge problems or criticism and do not handle it appropriately (e.g., due to their emotional attachment to the project, fear of failure), problems harden, leading to delays, unfulfilled requirements etc.	TM, Spo, PMO	1,2,3, 4,5,6, 7,8	2,5,9,13
Disregarding external advice	Advice of external consultants is ignored by stakeholders responsible for project	Cus, PMO	1,2,3, 5	11,12
Ignoring alternative solutions	Not acknowledging possible courses of action alternative to the project and not willing to explore their feasibility	Spo, PMO	1,2,3	12

Customer-contractor relationship: All factors with regard to the relationship between the customer and contractor organisation

Table A11. Customer-Contractor Relationship: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	**Description**	**Stakeholder**	**FD**	**Source**
Uncooperative relationship between customer and contractor	Lack of trust, hostile attitude, rivalry etc. can arise among customer's and contractor's stakeholder groups, leading to conflicts, ineffective collaboration, lack of understanding each other's needs, mutual recriminations etc.	Pro	1,3,5, 6,7,8	2,4,9
Too much trust in contractor	Customer organisation entirely entrusts the contractor with various tasks that, at least to some degree, require customer involvement and control	Cus	6,7,8	14
Too much pressure on contractor	Too much pressure on the contractor due to an over-ambitious timetable and the accordingly aggressive pace result in reduced performance	TM, PMO	3,5,7, 8	5,7
Too little accountability demanded from contractor	Customer stakeholders responsible for the project do not demand accountability from the contractor, leading to negligence, delays etc.	TM, Spo, PMO	1,5	7

Technology: Factors in any way related to technology

Table A12. Technology: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
Technical problems	Comprises technical problems in all phases of the system life-cycle, e.g., hardware failure, data loss etc.	N/A	1,2,4, 5,8	2,6,7,13
Limited technology	Applied technologies are still in their infancy and not sufficiently powerful for intended application environment	Spo, PMO	7,8	3
Technological uncertainty	Various aspects of technological uncertainty, e.g., applied technologies maturing at different pace, uncertainty about future support of applied applications etc.	Spo, PMO	6	3
Poor system quality	Different shortcomings in system quality like defects in software or hardware, poor usability, poor response time etc., leading to development delays and user resistance	Con, Spo, SE	3,8	5,8,9

Unexpected events: Unanticipated events occurring during the project

Table A13. Unexpected events: Description and stakeholder involvement (adapted from Pankratz and Basten, 2013).

Factor	Description	Stakeholder	FD	Source
New legal regulations	Authorities enact new legal requirements, which must be fulfilled; usually involves fixed deadlines and plan changes	Reg	6	4
Key staff changes	In case one or several key stakeholders leave (for various reasons), negatively affecting the project, others have to take over their tasks. This leads to process disruptions and delays; often, equivalent substitutes are not found at all	Pro	1,3,4	1,6,7,9,10
Late changes of requirements	Requirements are changed in late phases of the development process, usually leading to cost and budget overruns	Spo, PMO, EU	1,2,3	12
Supplier delays	Supplier delivers too late, e.g., due to unrealistic schedule	Sup	1	7

Appendix B

B1. Bandon Group Scenario

See http://www.stephenrgulliver.online/DBA/Bandon Group Scenario.docx for an electronic copy of the Bandon Group Scenario

Henley Business School
UNIVERSITY OF READING

Bandon Plc – ERP/CRM Feasibility

Business Background
Bandon Group is a US family owned distributor of copiers, electronic printers, faxes, and other office equipment. The company was started by Bud Brandon, who bought a copier dealership in Phoenix in 1976. Through Bud's entrepreneurial skill, motivation, and commitment to customer service, Bandon Phoenix aggressively gained market share and grew to $10 million in sales in the Phoenix marketplace by 1985. One of Bud's greatest accomplishments was the creation of Brandon Leasing Company, which held leases on copiers and electronic printers and became a major source of positive cash flow.

Excellent customer service, technical support, and innovative products enabled the company to grow continuously through the 1980s, and profits enabled Bud to purchase another copier franchise in Salt Lake City. By 1995, the Salt Lake City dealership grew to $10 million in sales.

When Bud passed away in 1997, his two sons, Ed and Steve Bandon, continued the business. Their growth strategy was to acquire additional dealerships in growing markets. By 2010, Bandon had grown to four divisions in four different markets in the western U.S. Portland, Oregon; Phoenix, Arizona; Salt Lake City, Utah; and Denver, Colorado. Each division president is responsible for developing sales and marketing strategies that will meet customers' needs in the market segment. This decentralised sales strategy enables divisions to meet the needs of their respective markets.

The corporate headquarters in Phoenix, handles central administrative functions and information systems support for order processing, billing, accounts payable, and accounts receivable. The divisions report to Ed and Steve Bandon, the co-owners of Bandon Group, Inc. The primary objective of senior management is to generate a 10% profit on sales, so profits can be used to re-invest into the overall enterprise and to purchase new division in markets that are growing in importance.

The mission, values, goals and objectives of Bandon Group, Inc., are expressed in the views of Ed Bandon, its co-owner: "Our objective is to provide office information systems supported by a networking infrastructure which facilitates information sharing and systems integration." In addition, notes Steve, its co-owner, "Bandon Divisions can offer value-added services and technology integration which meets the needs of customers in their respective marketplaces. Our responsiveness to customer needs is key to our profitability and to our market success."

One of the important elements of the company's profitability is its excellent sales organisation and professional service organisation. Its salespeople receive extensive training from experienced sales managers. Its service technicians are among the best in the industry and maintain high levels of expertise in problem diagnosis, troubleshooting, and reconciliation.
The competitive environment includes large national manufacturers, such as IBM and Xerox, which are managed through branches in major metropolitan areas. Bandon Group and its divisions have effectively competed by serving the needs of mid-market companies (i.e. $25 - $400 million in sales) and by offering mid-tier equipment (e.g. copiers, faxes, electronic printers) at cost-effective prices in regional markets. Their ability to offer quality-manufactured products (e.g. Canon, Minolta, Kyocera Mita, Sharp) has given their dealerships a reputation for quality and superior service at cost-effective prices.

Information Systems Environment

In the 1990s, Bandon Group contracted with a software development firm to develop customer software for its industry. Its administrative information systems were developed over a ten-year time-frame and handles major administrative and accounting functions, including order processing, inventory control, accounts receivable, accounts payable, general ledger, and meter click billing. Most of the information systems functions for applications supporting the business are generic, but the meter click billing software is unique to the industry. As a result, it made sense to contract for proprietary, or customised, software to support the business applications. The software was written in Business Basic, and the applications ran on an HP server in a Unix operating system environment.

Acquisition of OMD

By 2009, Bandon Groups business expansion meant the company had outgrown its legacy systems. At the time, it hired a full-time Director of Information Technology, Brian Manning. The Director of Information Technology reported to the Vice-president of Finance, William Bruen, within the Corporate Headquarters of Bandon Group Inc. One of Brian's first responsibilities was to search for a commercial off-the-shelf package that supported the administrative information system of Bandon Group, Inc. After a lengthy analysis, the company selected Office Machines Dealership (OMD), a package developed by a larger dealer.

The OMD System was being adopted by many dealers across the country because it included software supporting the meter-based billing application, used in the copier industry. Meter-based billing in the copier industry is similar to the meter-based billing in the utilities (e.g., gas) industry. In most cases, customers obtain a contract for a certain volume of copies per month, and their billing is based upon this contract. To monitor usage, customers report their meter reading, and any overage (above contract volume) is additionally billed. In some case, customer contract for a cost per copy basis, and they are billed according to this volume. The meter-based billing software within OMD was written in COBOL. Enhancements to the core OMD system included many sales management and service management reporting systems, which the prior versions did not include. OMD uses a dealer advisory board to obtain recommendations for future enhancements and modifications to the package. One enhancement is a web-based interface for customer entry of meter reading. This enhancement is called I-Manager.

One of the limitations of OMD is that it was not built using a relational database. As a result ad-hoc query and reporting is difficult, and managers have to stick with periodic reports provided by the system. Most of the reports are obtained by request to the systems group since generating these reports require knowledge of the OMD report generator. Some managers complain about OMD's lack of flexibility, and attempts were made to transfer data extracts from the OMD data files into microcomputer-based database files using Microsoft Access so that the managers can make these queries and generate on-demand reports. However, the complexity of the OMD database makes it difficult to create these data extracts and to refresh them on a timely basis.

Connecting the Divisions

Another major responsibility of the Director of Information Technology is to serve the IT needs of the division. By 2010, the four divisions were connected to the central OMD system. Brian spends a major proportion of his time designing and maintaining a telecommunications network with T-1 capability to connect each of the division to the central OMD administrative system in Phoenix.

Sale Prospecting

The office systems dealership industry depends upon effective sale prospecting. The typical sales representative uses a prospect database to make 25 calls each day. Of these 25 calls, five translate into an opportunity for an equipment demonstration. Of these five demonstrations, one or two might lead to an actual sale. Sales prospecting is critical to the success of the sales representatives throughout the industry.

In 2007, Bandon Salt Lake acquired Pivotal, a sales prospecting tool, which supported ad-hoc queries in a relational database environment. Sale support analysis use external market databases within Pivotal, and these were used to support the sale representatives. In addition, existing customer data was re-keyed into Pivotal from the OMD customer database because Pivotal and OMD were not integrated. In 2008, Bandon Phoenix and Bandon Portland adopted Pivotal as their sale prospecting tools. In 2010, Bandon Denver adopted Pivotal. These divisions adopted a similar strategy of importing from external market databases into the Pivotal database to create sale leads. As with Bandon Salk Lake, internal customer data had to be re-keyed from OMD into the Pivotal database because OMD and Pivotal were not integrated. Over time, this created inconsistencies between the OMD and Pivotal datasets and resulted in a duplication of effect in maintaining these two dataset environments.

Across the divisions, the Pivotal databases were used to varying degrees. At Bandon Salt Lake City, external market data and internal customer data were entered into the Pivotal databases to create sales leads. At Bandon Portland, external market data and internal customer data were used for sales prospecting as well. At Bandon Denver, the Pivotal sale prospecting system was introduced, but the licenses fell out-of-date, and data was not entered periodically. As a result, sales representatives created their own local prospect databases, using the contact management tool within Microsoft Access and GoldMine, a popular microcomputer-based sales and contact management system.

At Bandon Phoenix, a number of sophisticated Pivotal-based Customer Relationship Management (CRM) applications were developed by an internal systems developer between 2005 and 2010. For example, Pivotal applications developed at Bandon Phoenix generates service alerts when a particular customer calls in a service call more than three times in one month. Another Pivotal report, an excess volume report, generates a customer alert whenever copier volume on a particular unit runs 150% over its recommended volume. This information enables the sale representatives assigned to this customer to follow-up with the customer to determine if an upgrade is appropriate. To date, over 50 CRM applications run in the Pivotal environment at Bandon Phoenix. These applications support territory management, lead sales forecasting, customer retention, sales analysis, and sale compensation.

Evaluating CRM Solutions

The importance of sales prospecting to the division led the division presidents at Bandon Portland, Brandon Salt Lake and Bandon Denver to seek alternative sale prospecting and CRM software solutions.

Since each division tries to meet the needs of its respective marketplace, the division presidents sought software solutions that supported their application requirements. The division president in Portland, Salt Lake City, and Denver considered adopting the Pivotal CRM applications, which had been developed in Phoenix, but they felt these applications were too extensive and complex to meet their needs and did not meet their unique requirements. One important achievement in Phoenix was the creation of a data migration path between the OMD database and the Pivotal database. With the help of Brian Manning, the Director of Information Technology for Bandon Inc., data from the OMD database is used to refresh and update the Pivotal CRM database in Phoenix on a weekly basis.
Between November 2012 and August 2013, the other divisions analysed and evaluate the other sales prospecting and CRM applications. Robert North, the Division President at Bandon Portland, decided to pilot the new Microsoft CRM package and to customise it for their use. One of the advantages of the new Microsoft CRM package was its integration with Microsoft Office applications, including Excel, Outlook, and Access. A limitation, however, was its lack of integration with the proprietary OMD database and proprietary OMD operating system. Robert hired a consulting firm to address the challenge of creating a data migration path between the existing OMD database, so customer data from OMD could continuously refresh the CRM database.

Edmund Scott, the Division President of Bandon Salt Lake, decided to implement a sales prospecting package, which had been developed by another copier dealership in Pittsburgh. The Soaring package supported lead management and sales prospecting. In addition, the Soaring package used a Microsoft SQL Server database, permitting ad hoc queries and on-demand reports. One of the major advantages of Soaring package was its integration with the OMD legacy system database, and this permitted the migration of customer data from OMD to Soaring for customer account follow-up and analysis purposes.

With Phoenix using, Portland piloting the Microsoft CRM, and Salk Lake City, implementing Soaring, John Werner, the Division President of Bandon Denver decided to rely upon local microcomputer-based sales prospecting software, including the contact management system within Goldmine, until such time as one of the solution was proven to be most cost-effective. John did not want to spend a lot of money and time on an expensive CRM application, when other more cost-effective solutions existed.
The lack of integration among the four different sales prospecting / CRM environments and the central administrative information systems and customer databases posed a problem to Brian Manning, the Director of Information Technology at Bandon Group Inc. It was difficult for him and his small staff to support numerous sales prospecting applications, each of which required data migration from the OMD database to the CRM environment on a periodic basis. While the Soaring software was integrated with the OMD database, it had limited functionality outside the traditional copier line of business, and the other division presidents felt strongly that their CRM tools needed to support new and emerging lines of business, including information systems consulting, document outsourcing, colour graphics, and document management.

An Information Systems Study for Bandon Group
Ed and Steve Bandon, the co-owners of Bandon Group Inc. felt that it was time to do an information systems study to determine how Information Technology (IT) could best support the overall mission, goals, and objectives of the corporation over a three to five-year period of time. While they recognised that each division had a right to pursue autonomous CRM and sales prospecting applications, they saw that this approach created duplication of effort, sub-optimised the outcome, and caused a great deal of extra expense. In addition, the central IT staff managed by Brian Manning, was small and had trouble providing data migration, network support, technical support, and training for four different local sales prospecting and CRM solutions.

Another factor motivated the information systems study. Other large copier dealerships were beginning to implement enterprise systems solutions, including SAP and Oracle ERP. These enterprise system solutions provide administrative systems, grounded in relational database technology, which allowed cross-functional integration. This integration included support for front-end applications such as CRM, which were integrated with the ERP and SCM systems.

Many competitive dealerships were moving towards e-Business solutions, which enabled web-based supply ordering, service call entry, and meter click reporting. In this competitive environment, Ed and Steve Bandon felt it was time to move forward toward e-Business solutions. However, the legacy OMD system had a propriety database and was not integrated with the various CRM solutions adopted by the division, making it almost impossible to move towards implementation of an e-Business solution. E-Business requires a foundation in administrative systems supporting order entry, service call management, customer service, and supply ordering, and the foundation enterprise systems were not in place at Bandon Group Inc.

Need for an Information Systems Study

With these pressing issues in hand, Ed and Steve Bandon decided to bring in an external information systems consulting firm to analyse the current information systems environment, to assess problems with the current environment, and to propose changes in systems to enable the company, including its respective division, to achieve the sales and service objectives.

In addition to assessing the feasibility of implementing enterprise system solutions, Ed and Steve wanted the consultant to address senior management concerns, such as the need for more information for tactical and strategic management, the need to standardise business processes, and the need for more targeted marketing. The centralised versus decentralised organisation of IT was a dilemma. Over the last ten years, the sales prospecting and CRM applications had become totally decentralised and under the control of each autonomous division. Though this provided flexibility and control over data, it added considerable expense and made it difficult for centralised IT to support this environment.

In the current environment, addressing the issues of e-Business and data integration is difficult. Managers within all the division were seeking better management information, but with the current systems, it was almost impossible to provide ad hoc queries and on-demand reporting. It seemed that each new IT issue was being address by a piecemeal or ‘fire-fighting’ plan to spell out directions for central and decentralised IT and to enable divisions to achieve strategic marketing objectives.

Seminar Sessions

In these seminar sessions we will critically consider, in context of failure literature, whether Bandon Group Inc. should or should not pursue a combined ERP / CRM enterprise systems solution.

B2. Introduction Seminar - Bandon

Seminar Slides -See http://www.stephenrgulliver.online/DBA/Scenario.pptx for an electronic copy of the seminar slides.

Information Sheet - All students were required to sign-up, and login, to the online system. The following information was provided to all students upon login.

This research project investigates how individual differences impact business perception of systems conflict, technology acceptance, and IS project failure factors, in order to provide a better understanding whether certain individuals are more prone towards certain type of thinking and attitudes. The research forms part of a DBA academic qualification at Henley Business School at the University of Reading.

Data collection has been designed as part of a series of teaching experiences, to expand your understanding concerning information systems management. Data collected will support your classroom experience, however data will be used anonymously as part of our wider research activities. With your permission, I would like to use online data in research analysis. The data will be kept securely and destroyed after the completion of the project.

At every stage your identity will remain confidential. Your name and identifying information will not be included in the final report. A copy of the completed project can be made available upon request.

The project has been subject to ethical review in accordance with the procedures specified by the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct.

If you have any further questions about the project, or you wish for your data to be removed from analysis, please feel free to contact me at the email address below.

Name of researcher: Dr. Stephen R. Gulliver

Email address: s.r.gulliver@henley.ac.uk

Demographic Information

Upon login all students were asked for basic demographic

Age

A text form is needed

Gender

M/ F

Years of Experience in Business

A text form is needed

First Name :
Second Name :
Email :

Gender :
Age :
Subject of Study : <PULL DOWN MENU>
Computer Science / IT
Business Science
Management
Accounting
Finance
Economics

Years of commercial experience:

Nationality : <Pull Down ??>
Other <TEXT> :

Country of Residence : <Pull Down ??>
Other <TEXT> :

B3. Seminar 1: Systems Conflict

Seminar Slides
See www.stephenrgulliver.online/DBA/Session 1 - Conflict.pptx for an electronic copy of the seminar slides.

Conflict Seminar Steps
STEP 1
Briefly re-introduce the scenario

SIGNIN – using Email

Discuss Front Page options

Session 1_1 selection

STEP 2 – ON OWN
"Let's consider nine conflicts that will exist between the old (i.e. OMD) and new (i.e. ERP/CRM) information systems:
1. A new RDBMS would not interface with the existing OMD proprietary database.
2. Current meter-click billing process in OMD, which is used as basis of the billing process, is not commonly available in new ERP/CRM solutions
3. New cloud/network technology is driving a change in business toward use of the paperless office – do people still need photocopiers?
4. Separate information systems used within Bandon Inc does not support centralised data analytics.
5. Current processes operate at a divisional level, and do not support centralised maintenance/decision making.
6. Divisional working results in poor streamlining / consistency of processes
7. Old technology does not facilitate mobile business models
8. Existing processes limit support of digital business opportunities
9. Digital (paperless) business is not considered by current business focus"

i) I<u>n your own opinion</u>, in the pull down menus, order the statements in order of importance.

{Nine pull down menus}

// SUBMIT– feedback is available from the FrontPage

// Get people in groups. Group leader needs to provide each group with a code.
Each group is then given a group code.

Each person should select session 1_2 from the Front Page

Session 1_2

STEP 3 – IN GROUPS
In groups (ensuring teachers have given each group a code) discuss issues and agree on the group agreed order.

Each participant should enter the agreed issues and group code

STEP 4 -
Discuss in groups whether you all agreed on the order of issues, and the differences, and why the differences in opinion occurred.

- OPEN TEXT BOX

Each participant can enter a comment concerning their feelings about the agreed list – i.e. whether they agree or not (and why).

// Check all students have submitted

BREAK (at the session leader's discretion)

STEP 5 – AS GROUP
Introduce the fact that when two systems come together, one or both systems will need to change (e.g. ERP can be customised, or Bandon need to apply process change).

Selection Session 1_3 from FrontPage

Session 1_3

STEP 6 – ON OWN
i) Judge the following statements:

// Feedback gained on a 5 point Likert scale (1- Totally Disagree, 2 – Disagree, 3 – I'm Neutral, 4 – Agree, 5 – Totally Agree).

1. Bandon should use the ERP/CRM in all divisions.
2. The new ERP/CRM will need to be customised to ensure it satisfies Bandon's needs.
3. Bandon's existing technology needs to be customised, within each division, to be compatible with the ERP/CRM technology.
4. The ERP/CRM processes need to be changed to fit with the Bandon's current business processes.
5. Bandon's existing processes need be changed to support the new ERP process.
6. People will need to change their way of working if the ERP/CRM technology is

adopted in place.

7. Interaction technology should be customised to minimise the impact on people's behaviour.
8. Staff in Bandon won't want to use the new ERP/CRM technology at all.

// SUBMIT – OUTPUT SCREEN & EMAIL – with visible feedback

CALCULATING FEEDBACK

Statement 2 (CNT), statement 4 (CNP) and statement 7 (CNB) are used to collect information about attitude toward changing the new system. Statement 3 (CCT), statement 5 (CCP) and statement 6 (CCB) are used to represent attitude towards changing the current system). Statement 1 and 8 are used to work out the KANO state.

STEP 7 – DISCUSSING FEEDBACK

Scores (2 to 10) will be automatically created for each of the contact points:

TI = CNT + CCB

TF = CNT + CCP

TT = CNT + CCT

FT = CNP + CCT

IT = CNB + CCT

FI = CNP + CCB

FF = CNP + CCP

IF = CNB + CCP

II = CNB + CCB

Discuss that numbers reflect student's opinion which conflict areas are most likely. If high numbers are on the left then the student is worried about changing the new technology to fit the company. If high numbers are on the right, then the student is worried about changing the company to fit the new technology.

Table B3.1. Kano's Evaluation Table

Customer Requirements		Dysfunctional (negative) question **(Statement 8)**				
		5. Strongly Agree	4. Agree	3.I'm neutral	2. Disagree	1. Slightly disagree
Functional (positive) question **(Statement 1)**	5. Strongly agree	Q	A	A	A	O
	4. Agree	R	I	I	I	M
	3. I'm neutral	R	I	I	I	M
	2. Disagree	R	I	I	I	M
	1. Slightly disagree	R	R	R	R	Q
A: Attractive, **O:** One-dimensional, **M:** Must-be, **I:** Indifferent, **R:** Reversal, **Q:** Questionable						

Feedback provided student with information about whether they think the introduction of ERP/CRM into Bandon is important. Results are A: Attractive, O: One-dimensional, M: Must-be, I: Indifferent, R: Reversal, Q: Questionable

- Must-be (M) means that the technology fulfils basic needs. Removing the technology will cause user dissatisfaction, as the technology is critical to basic needs.
- One-dimensional (O) means that an increased use of the technology results in increased satisfaction. Although not essential to basic functional needs, there is a lack of fulfilment when it is not there.
- Attractive (A) means that use of the technology satisfies the individuals, though individuals do not actually need it to meet any functional needs. Removal of an attractive technology will not cause dissatisfaction, as use of the technology was desirable, but not expected. Indifferent (I) means that individuals do not respond to, or care about, the presence of the technology.
- Reversal (R) means that technology fulfils the individual needs, yet causes dissatisfaction when used.
- Questionable (Q) means the answer appears to be in conflict

The following php code was designed to provide students with feedback concerning KANO variables:

```
<?php
session_start();
include "dbConn.php";

$sql = "SELECT * FROM s1_3 WHERE
email = '".$_SESSION['email']."'";
$statements = array();
$statements[0] = 0;
$result = $conn->query($sql);
   if ($result->num_rows > 0) {
                  $row = $result-
>fetch_assoc();
                  for ($i = 1; $i <= 8; $i++)
                           $statements[$i] =
$row["q".$i];
         }
         $TI = $statements[2] +
$statements[6];
         $TF = $statements[2] +
$statements[5];
         $TT = $statements[2] +
$statements[3];
         $FT = $statements[4] +
$statements[3];
         $IT = $statements[7] +
$statements[3];
         $FI = $statements[4] +
$statements[6];
         $FF = $statements[4] +
$statements[5];
         $IF = $statements[7] +
$statements[5];
         $II = $statements[7] +
$statements[6];

         $kano = "";
         $kanoR = "";
         // Kano result
         $s1 = $statements[1];
         $s8 = $statements[8];
         if ($s1 == 5 && $s8 == 5) {
                  $kano = 'Q';
         }
         else if ($s1 == 4 && $s8 == 5) {
                  $kano = 'R';
         }
else if ($s1 == 3 && $s8 == 5) {
         $kano = 'R';
}
else if ($s1 == 2 && $s8 == 5) {
         $kano = 'R';
}
else if ($s1 == 1 && $s8 == 5) {
         $kano = 'R';
}
else if ($s1 == 5 && $s8 == 4) {
         $kano = 'A';
}
else if ($s1 == 4 && $s8 == 4) {
         $kano = 'I';
}
else if ($s1 == 3 && $s8 == 4) {
         $kano = 'I';
}
else if ($s1 == 2 && $s8 == 4) {
         $kano = 'I';
}
else if ($s1 == 1 && $s8 == 4) {
         $kano = 'R';
}
else if ($s1 == 5 && $s8 == 3) {
         $kano = 'A';
}
else if ($s1 == 4 && $s8 == 3) {
         $kano = 'I';
}
else if ($s1 == 3 && $s8 == 3) {
         $kano = 'I';
}
else if ($s1 == 2 && $s8 == 3) {
         $kano = 'I';
}
else if ($s1 == 1 && $s8 == 3) {
         $kano = 'R';
}
else if ($s1 == 5 && $s8 == 2) {
         $kano = 'A';
}
else if ($s1 == 4 && $s8 == 2) {
         $kano = 'I';
}
else if ($s1 == 3 && $s8 == 2) {
         $kano = 'I';
}
else if ($s1 == 2 && $s8 == 2) {
         $kano = 'I';
```

```
	}
	else if ($s1 == 1 && $s8 == 2) {
		$kano = 'R';
	}
	else if ($s1 == 5 && $s8 == 1) {
		$kano = 'O';
	}
	else if ($s1 == 4 && $s8 == 1) {
		$kano = 'M';
	}
	else if ($s1 == 3 && $s8 == 1) {
		$kano = 'M';
	}
	else if ($s1 == 2 && $s8 == 1) {
		$kano = 'M';
	}
	else if ($s1 == 1 && $s8 == 1) {
		$kano = 'Q';
	}
	if ($kano == 'A')
		$kanoR = 'Attractive';
	else if ($kano == 'O')
		$kanoR = 'One-
dimensional';
	else if ($kano == 'M')
		$kanoR = 'Must-be';
	else if ($kano == 'I')
		$kanoR = 'Indifferent';
	else if ($kano == 'R')
		$kanoR = 'Reversal';
	else if ($kano == 'Q')
		$kanoR = 'Questionable';
?>
<html>
<head>
<script>
function FrontPage() {
	window.location =
"FrontPage.php";
}
</script>

<style>
body {
	background-color: powderblue;
}
</style>

</head>
<body>
<center>
<h1>FEEDBACK for <?php echo
$_SESSION['email']; ?></h1>
<table>
<tr>
<td>TI</td><td><?php echo $TI?></td>
</tr>
<tr>
<td>TF</td><td><?php echo $TF?></td>
</tr>
<tr>
<td>TT</td><td><?php echo $TT?></td>
</tr>
<tr>
<td>FT</td><td><?php echo $FT?></td>
</tr>
<tr>
<td>IT</td><td><?php echo $IT?></td>
</tr>
<tr>
<td>FI</td><td><?php echo $FI?></td>
</tr>
<tr>
<td>FF</td><td><?php echo $FF?></td>
</tr>
<tr>
<td>IF</td><td><?php echo $IF?></td>
</tr>
<tr>
<td>II</td><td><?php echo $II?></td>
</tr>
</table>

<h1>Kano's Evaluation</h1>
<h2>Your result is: <?php echo $kanoR
?></h2>
<input type = "button" value = "back"
onclick = "FrontPage()"/>
</center>

</body>
</html>
```

B4. Seminar 2: Technology Acceptance

Seminar Slides - See http://www.stephenrgulliver.online/DBA/Session 2 - Technology Acceptance.pptx for an electronic copy of the seminar slides.

Technology Acceptance Seminar Steps - Bandon are considering implementation of a combined ERP/CRM solution.

In this session we will be considering technology acceptance factors – so students that students can critically consider why technology is (or is not) accepted.

STEP 1: PRESENTATION

- **COVER SLIDES ENTITLED 'Technology Acceptance'.** Introduce Technology acceptance models – getting students to consider the factors that impact intention and behaviour.

STEP 2 - @ SLIDE 8 DATA ENTRY "Do you think Bandon will accept the new technology?"

- As the questions should be based on the student's perception of the Bandon scenario – i.e. will they accept the ERP/CRM?

FOR SLIDES 9 to 15 -

students should answer (ON THEIR OWN DEVICE):

(1- totally disagree, 2 – slightly disagree, 3 – not sure, 4 – slightly agree, 5 – totally agree)

PERCEIVED BENEFITS
Performance Expectancy

1. The proposed change will not improve Bandon's technology capability
2. The proposed change will not improve Bandon's business processes
3. The proposed change will not improve Bandon's business model
4. The change will not increase Bandon's profits.
5. The change will not increase Bandon's turnover.
6. The change will not enable Bandon to accomplish tasks more quickly.
7. The change will not benefit Bandon's suppliers.
8. The change is not likely to improve end customer satisfaction.

PERCEIVED EFFORT

Effort Expectancy

1. Bandon will not easily implement the change.
2. Bandon’s technology will not be easy to change
3. Bandon’s processes will not need to change
4. Bandon’s business model will not need to change
5. The change will require considerable internal staff training.
6. The change will result in more administration processes.
7. The change will cost Bandon lots of money.
8. The change will take a long time.
9. The change will require considerable ongoing maintenance.

Social influence

1. It is important that Bandon management believe in change.
2. All managers (operational, middle, senior) should agree.
3. It is important that Bandon staff approve changes to technology.
4. It is important that Bandon staff approve changes to processes.
5. It is important that Bandon customers agree with changes.
6. It is important that Bandon’s suppliers agree with changes.
7. Competitors are making similar changes and it is important to keep up.
8. Technology innovation is pushing Bandon towards making this change.
9. External stakeholders (Government, investor) require this change.

Facilitating conditions

1. Bandon do not have the resources necessary to make this change.
2. Bandon’s current technology do not support the proposed change.
3. Bandon’s current processes do not support the proposed change.
4. Bandon’s staff do not have the skills needed to implement the ERP/CRM.
5. Bandon’s staff do not have the skill to maintain the ERP/CRM.
6. Bandon’s current business model does not support the proposed change.
7. Bandon’s staff already do not the skill to use the ERP/CRM.

Hedonic Motivation

1. Bandon management will not enjoy using the new software functionalities.
2. Bandon staff will not enjoy engaging in the change.
3. Bandon staff will not enjoy working with the ERP/CRM project team.
4. Bandon staff will not enjoy the required management / process changes change.
5. Bandon staff will not enjoy using the new ERP/CRM technology
6. Bandon staff will not enjoy using the new ERP/CRM processes
7. Bandon customers will not enjoy engaging with the new solution

Price Value

1. Bandon management do not understand the Total Cost of ERP/CRM Ownership
2. Management do not believe ERP/CRM software costs are reasonably priced.
3. Staff do not believe ERP/CRM software costs are reasonably priced.
4. Cloud solutions are worse value than local hosted solutions.
5. Bandon will not save money as a result of the change.
6. The ERP/CRM will not increase customer value of Bandon
7. The ERP/CRM will not increase supplier value of Bandon

Habit

1. People usually only use technology they are familiar with.
2. Management will want staff to develop new habits.
3. Staff will want to develop new habits.
4. Staff are unlikely to use the technology
5. Staff are unlikely to use the new processes
6. Customers are unlikely to use the ERP/CRM
7. Suppliers are unlikely to use the ERP/CRM

For each of the sections we should have a separate page with a pause point.

Session 2_2
STEP 3 – Feedback and discussion.

For each factor find average, i.e. SUM(P1: P8) / 8

Higher areas are areas that are seen by the student to be more likely to cause problems. These numbers will be save on the online frontpage and will be accessible for students in the future.

B5. Seminar 3: Systems Failure

Seminar Slides
See http://www.stephenrgulliver.online/DBA/Session 3 - System Failure.pptx for an electronic copy of the seminar slides.

In your opinion, in context of systems failure, what is the importance of the following:

Feedback gained on a 5 point Likert scale (1- unimportant, 2 – slightly unimportant, 3 – not sure, 4 – slightly important, 5 – totally important).

1. Developing a climate of trust, e.g., between employees and management
2. Clarity concerning the person responsible for IT in the business
3. The business strategy being understood by project team before project initiation
4. Project contractors remaining throughout the project lifecycle
5. Consideration of contractor experience
6. Alignment of implementation approach and company
7. Ensuring the selected technology functionality aligns to customer strategy
8. The project contractor costs are correctly estimated, i.e., managing expectations
9. Development of a correct and true business case, e.g., appropriate operating expectations
10. The project team do not feel they need to not lie about project progress
11. All project team members understand of the chosen implementation approach
12. The project team apply strong project control mechanisms
13. There is rigorous application of the project management method
14. Requirements documents describe “how” requirements are going to be implemented
15. Users are familiar with the information technology solution being used
16. Consideration of stakeholders that are negatively affected by the change of power
17. Appreciation that IT does not guarantee changed management practices, i.e., no silver bullet
18. The existence of a well-known project champions
19. All stakeholders’ viewpoints are appreciated during the project lifecycle
20. Team not acknowledging/ considering alternate courses of action available to the project
21. Clients not demanding accountability from the contractor
22. Shortcomings in the system quality, e.g. defects, poor usability, poor response time etc.
23. Technologies maturing at different paces, i.e. uncertainty about future support
24. Swapping of roles if key stakeholders leave
25. New legal requirements that must be fulfilled
26. Late requirements change

In your opinion what are the three most important issues – check pull down menus.

Table B5.1 Mapping of Pankratz and Basten questions to categories and dimensions.

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**CAT**
1. Climate of mistrust with customer organisation				4	5				1
2. Lack clear responsibility of IT						6			1
3. Unclear strategic goals						6	7	8	1
4. Replacement of the contractor	1								2
5. Insufficient contractor experience			3						2
6. Develop approach not understood				4					3
7. System does not suit						6	7	8	3
8. Understanding of Effort	1	2			5				4
9. False business case						6			4
10. Management status report	1	2			5				5
11. Inappropriate development approach	1	2		4					5
12. Loose Project control				4		6	7	8	5
13. Project Management Method			3	4	5				5
14. Inadequate requirements specification			3				7	8	5
15. Users lack of using IT							7	8	6
16. Redistribution of Power							7		6
17. It consider a magic bullet							7	8	6
18. Limited prestige								8	6
19 Disregarding difference perception								8	6
20. Ignoring alternative solutions	1	2	3						7
21. Too little accountability demanded from contractor	1				5				8
22. Poor system quality			3					8	9
23. Technological uncertainty						6			9
24. Key staff changes	1		3	4					10
25. New Legal regulations						6			10
26. Late changes of requirement	1	2	3						10
No OF FD	8	5	7	6	5	7	7	9	

FIN