The Business Impact of Information Systems:
A Unified Theory and Empirical Test

Master's Thesis
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Abstract

Past research in information technology (IT) has yielded many competing models and different antecedents of IT acceptance have been proposed and analysed (Venkatesh *et al.*, 2003). Especially in these times, when considering "the unprecedented decline of the global economy is impacting the IT industry with worldwide IT spending forecast to total $3.2 trillion in 2009, a 3.8 per cent decline from 2008 revenue of nearly $3.4 trillion" (Gartner, 2009) it is of vital relevance to estimate as accurate as possible the returns and risks involved in IT investments.

In their systematic and comprehensive analysis, in which they "use a combination of quantitative and qualitative techniques", Moody *et al.* (2009) identify the top 5 most influential core theories of the Information Systems (IS) field. These theories currently dominate the IS field in explaining the acceptance and adoption of IT investments.

However, as this thesis points out, the existing theories contradict at some critical points. Additionally, there is a significant overlap between the theories. Finally some of the theories seem to lack a consistent operationalization in order to make it applicable in an empirical context.

This thesis presents a new, comprehensive theory that explains and predicts the acceptance of information systems, as well as the (financial) returns or business impact. The theory is called:

Unified Theory of Information System Success (UTISS)

The overall goal of this Masters Thesis is (1) to formulate the UTISS theory that unifies the current IS paradigms: the *Technology Acceptance Model,* the *IS Success Model,* the *Task to Performance Chain*, and the *Unified Theory of Acceptance and Use of Technology,* (2) to extent its foundations by including other reference disciplines (i.e. marketing and software engineering), and (3) to empirical validate UTISS.

After presenting the comprehensive model, a combination of qualitative and quantitative techniques are used to show that (1) the UTISS model is sufficiently operationalized and hence can be applied meaningful to empirical contexts, and (2) the theory appears to be useful in assessing current IS implementations.

During their extensive longitudinal healthcare investigation, Devaraj & Kohli (2003) proposed and concluded that "the driver of IT impact is not the investment in technology, but the actual usage of the technology". The findings in this thesis support their conclusion as well as their suggestion that careful investigation and estimation of IT usage is relevant, especially for those who are practically involved in IT projects.

There is nothing so practical as a good theory.
-- Kurt Lewin

This Masters Thesis deviates from traditional Masters Theses in the sense that it proposes a theory whereas other theses usually apply existing theories. The proposition of Kurt Lewin is demonstrated by including an empirical test of the proposed theory.

The explicit scientific nature of this thesis – and its purpose to publish it in a prominent peer-reviewed journal – has its repercussion on the format: concise rather than extensive as one might expect a Master Thesis to be.

Acknowledgements

In the very first place I would like give credits to the organization that made it possible to conduct the empirical research: PricewaterhouseCoopers, in particular my daily sparring partner and supervisor Erik Westrum. Like a clairvoyant, he predicted some critical changes in the process of writing a thesis (e.g. the exclusion of the literature review part), probably because he has hands-on experience in thesis-writing.

I am grateful to my colleagues Maarten Buitink, Chiel Meulendijks (a.o.) from PwC department *System and Process Assurance (SPA)* as well for there intermediate tips and tricks, especially with regards to the technical details of invoice automation.

My roommate Kees Cruijsen, who was also writing his thesis and always in for a funny joke with colleagues, as well as my girlfriend helped me to put things into perspective every once in a while. I am grateful to my father for his feedback as well.

Although anonymously, I would like to thank the three collaborating organizations for their effort as well, especially the ones that paid extra effort in reviewing some parts by contacting me multiple times.

Last but certainly not least I would like to offer my sincere thanks to my university supervisors Daniel Moody and Roland Müller. Without their help, the triggering meetings we had, and the proposed challenges, this thesis would not have been as it is right now.

Contents

1 Introduction

In their systematic and comprehensive analysis, in which they "use a combination of quantitative and qualitative techniques", Moody *et al.* (2009) identify the top 5 most influential core theories of the Information Systems (IS) field:

1. Technology Acceptance Model (TAM) by Davis (1989);
2. IS Success Model (ISM) by DeLone & McLean (1992);
3. Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh *et al.* (2003);
4. Task to Performance Chain (TPC) by Goodhue & Thompson (1995);
5. Adaptive Structuration Theory (AST) by De Sanctis & Poole (1994).

According to Moody et al. (2009) both TAM and ISM are the current paradigms, whereas UTAUT and TPC are respectively their 'challengers'. In this thesis, these four theories are unified in one theory: *Unified Theory of Information System Success (UTISS).*

Why would it be useful to unify these theories? – As this thesis points out, the existing theories contradict at some critical points: some of the theories make use of the same measures to measure different things. Additionally, there is a significant overlap between the theories. Finally some of the theories, like DeLone & McLean (1992)'s IS Success Model, seem to lack a consistent operationalization in order to make it applicable in an empirical context.

Concluding, the theories that currently dominate the IS field seem to be far from perfect. However, IS practitioners or (IT) managers in business could certainly benefit from the existence of a unifying and operationalized IS success model to predict the impact and to assess the risks involved in an IS implementation project. Especially in these times, when considering "the unprecedented decline of the global economy is impacting the IT industry with worldwide IT spending forecast to total $3.2 trillion in 2009, a 3.8 per cent decline from 2008 revenue of nearly $3.4 trillion" (Gartner, 2009) it is of vital relevance to estimate as accurate as possible the returns and risks involved in IT investments.

Therefore, the objectives of this Masters Thesis are (1) to formulate a Unified Theory of IS Success (UTISS) that unifies the IS theories TAM, ISM, UTAUT, and TPC, (2) to extent its operationalization by 'borrowing' established instruments from other reference disciplines (such as the System Engineering and Management disciplines), and (3) to empirical validate UTISS.

After formulating the framework, a pilot test is carried out in multiple settings (i.e. at manufacturing companies and in a governmental foundation). Besides a cross-sectional comparison between the three organizations, a longitudinal comparison has been carried out as well. The primary purpose of gathering data was to assess the feasibility of the proposed items of the model.

The remainder of this thesis articulates the findings and implications for theory and practice. Especially organizations and practitioners can benefit from these findings since it is based on empirical benchmark data. Comparing for instance performance improvements as a result of an IS implementation can shed some valuable light, particularly for future implementation projects. This thesis ends with a short section devoted to potential limitations and future research directions.

2 Evaluation of the Current IS Paradigms

This chapter starts with a description of the current IS paradigms, as they were stated in the introduction. The original drawings are adopted and, as far as possible, the theories' elements (i.e. constructs and/or dimensions) are summarized in tables, along with their definitions. Furthermore, the main problems and challenges of theories are discussed such as the inconsistencies and overlap between them.

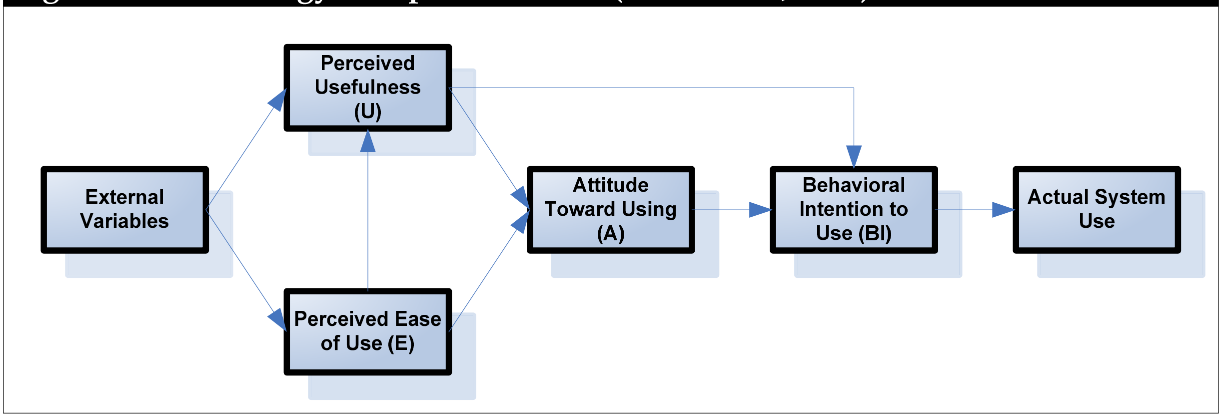
2.1 Description of the Most Influential IS Theories

The figures and tables below provide a brief overview of what the theories' major contributions are, which core constructs the authors distinguish, and how they are defined.

2.1.1 The Technology Acceptance Model (TAM)

Davis (1989) develops and validates scales for *perceived usefulness* and *perceived ease of use*, two variables that are hypothesized to be fundamental determinants of user acceptance. These variables (or constructs) are integrated in the Technology Acceptance Model (TAM), a highly cited framework developed by Davis *et al.* (1989) which is based on the Theory of Reasoned Action (TRA) from Ajzen & Fishbein (1980).

Figure 1 – Technology Acceptance Model (Davis et al., 1989)



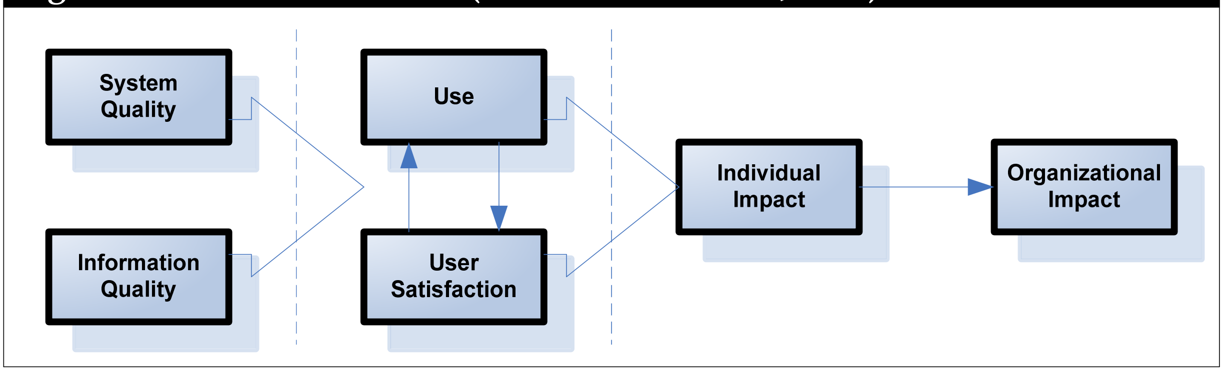
TAM is tailored to IS contexts, and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to better explain intention parsimoniously. TAM2, the updated version of TAM by Venkatesh & Davis (2000), extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings. TAM has been widely applied to a diverse set of technologies and users (Davis *et al.*, 1989).

Table 1 – TAM Definitions (Davis *et al.*, 1989)	
Construct	**Definition**
Perceived Usefulness	"The prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context."
Perceived Ease of Use	"The degree to which the prospective user expects the target system to be free of effort."
Attitude Towards Using	The authors do not provide an explicit definition. However, they state that according to TAM's foundational theory *Theory of Reasoned Action (TRA)* "a person's attitude toward a behavior is determined by his or her salient beliefs about consequences of performing the behavior multiplied by the evaluation of those consequences". Beliefs are defined as "the individual's subjective probability that performing the target behavior will result in the consequence and the evaluation term refers to an implicit evaluative response to the consequence".
Behavioral Intention to Use	"The user's behavioral intention to perform the use behavior."
Actual System Use	"Actual system usage". This construct is not defined in a more elaborative way.

2.1.2 The IS Success Model (ISM)

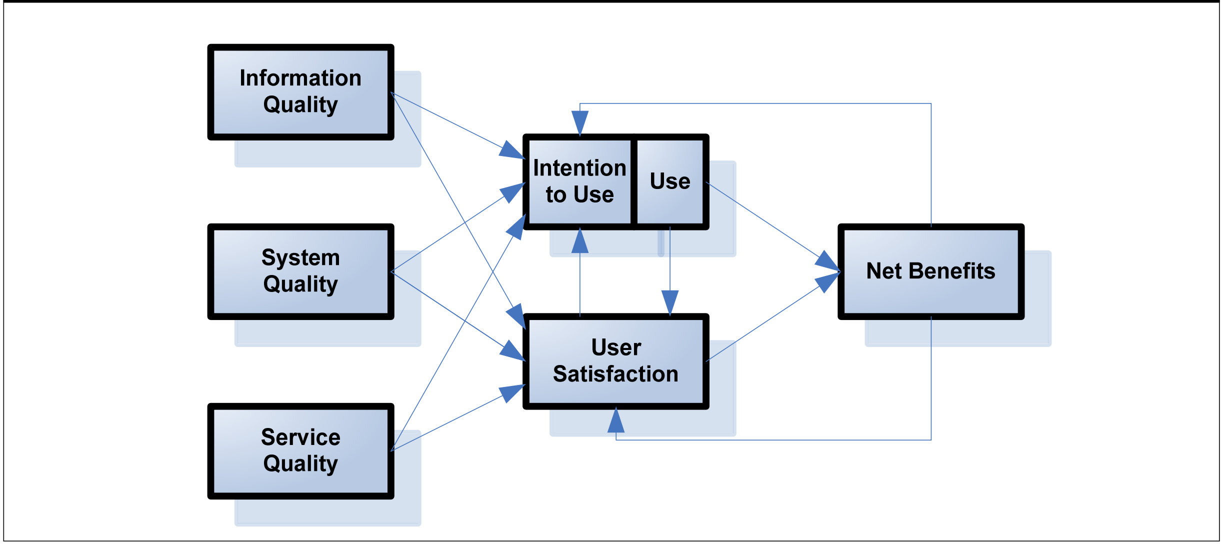
DeLone & McLean (1992) present a comprehensive taxonomy to organize the diverse IS research. They claim to present a more integrated view on the concept of IS success (figure 2).

Figure 2 – IS Success Model (DeLone & McLean, 1992)



DeLone & McLean (2003) revised their model rather minimally in 2003: they add an extra *service quality* construct and merge individual and performance impact into one *net benefits* construct, as it was promised that it would make the model less complicated. *Service Quality* and *Net Benefits* are derived from DeLone & McLean's (2003) updated article, however, they are included in table 2 as well.

Figure 3 – Updated IS Success Model (DeLone & McLean, 2003)



Because of this minor difference between the 1992 and 2003 papers, it is considered as *one* highly cited paradigm. DeLone & McLean (1992) also refer to their model as "categories of IS success". These categories are described briefly in the next table. One of the major objectives against this taxonomy is that the dimensions are not explicitly defined. Therefore the second column displays what could be considered as (part of) a definition, based on quotes from their articles in 1992 and 2003.

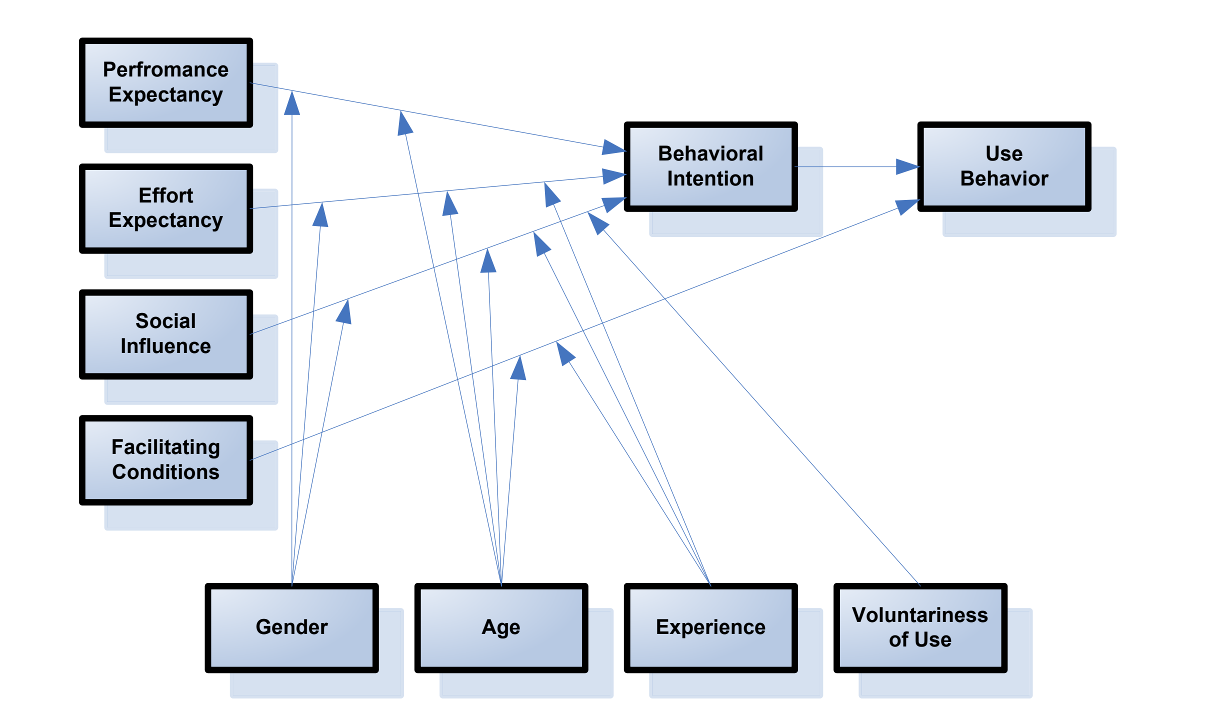
Table 2 – ISM Definitions (DeLone & McLean, 1992; 2003)

Dimension / Category	**Proposed Definition**
System Quality	"Focus on the desired characteristics of the information system itself which produces the information."
Information Quality	"The study of the information product for desired characteristics such as accuracy, meaningfulness, and timeliness. Or the quality of the information that the system produces, primarily in the form of reports."
Use	DeLone & McLean (1992) are not more distinctive about both dimensions than: "the interaction of the information product with its recipients, the users and/or decision makers".
User Satisfaction	
Individual Impact	"The influence which the information product has on management decisions".
Organizational Impact	"The effect of the information product on organizational performance".
Service Quality	"The overall support delivered by the service provider, applies regardless of whether this support is delivered by the IS department, a new organizational unit, or outsourced to an internet service provider (ISP). Its importance is most likely greater than previously since the users are now our customers and poor user support will translate into lost customers and lost sales".
Net Benefits	Rather than defining the dimension, DeLone & McLean (2003) state that: "there is a continuum of ever-increasing entities, from individuals to national economic accounts, which could be affected by IS activity. The choice of where the impacts should be measured will depend on the system or systems being evaluated and their purposes".

2.1.3 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The highly cited UTAUT model extends the TAM model and increases the explained variance in usage intention from approximately 50% (adjusted R^2) to 70% (Venkatesh *et al.*, 2003). Furthermore, UTAUT provides a useful tool for managers needing to assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions (including training, marketing, etc.) targeted at populations of users that may be less inclined to adopt and use new systems (Venkatesh *et al.*, 2003).

Figure 4 – Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)



Except for the constructs *Behavioral Intention* and *Use Behavior* Venkatesh *et al.* (2003) provide comprehensive definitions of the constructs in the model:

Table 3 – UTAUT Definitions (Venkatesh *et al.*, 2003)

Construct	Definition
Performance Expectancy	"The degree to which an individual believes that using the system will help him or her to attain gains in job performance."
Effort Expectancy	Effort expectancy is defined as "the degree of ease associated with the use of the system".
Social Influence	Social influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system".
Facilitating Conditions	Facilitating conditions are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system".
Behavioral Intention	Although "Behavioral Intention" is quite 'auto-explaining' term, Venkatesh *et al.* (2003) do not explicitly define what they mean with this concept.
Use Behavior	Idem as above: no explicit definition by Venkatesh *et al.* (2003) is stated.

2.1.4 The Task to Performance Chain (TPC)

Another stream of IS research focuses on the fit between technologies and users' tasks in achieving individual performance impacts from information technology. The framework of Goodhue & Thompson (1995) suggests that TTF could be the basis for a strong diagnostic tool to evaluate whether information systems and services in a given organization are meeting user needs (Goodhue & Thompson, 1995).

Their theoretical model (figure 5) is promised to be consistent with DeLone & McLean's (1992) Model of IS Success as it simultaneously adds to this model:

1. By highlighting the importance of task-technology fit (TTF) in explaining how technology leads to performance impacts. Goodhue & Thompson (1995) propose that task-technology fit is a critical construct that was missing or only implicit in many previous models.

2. By providing a stronger theoretical basis for thinking about a number of issues relating to the impact of IT on performance. For example making choices for surrogate measures of MIS success, understanding the impact of user involvement on performance, and developing better diagnostics for IS problems.

Figure 5 – Technology to Performance Chain (Goodhue & Thompson, 1995)

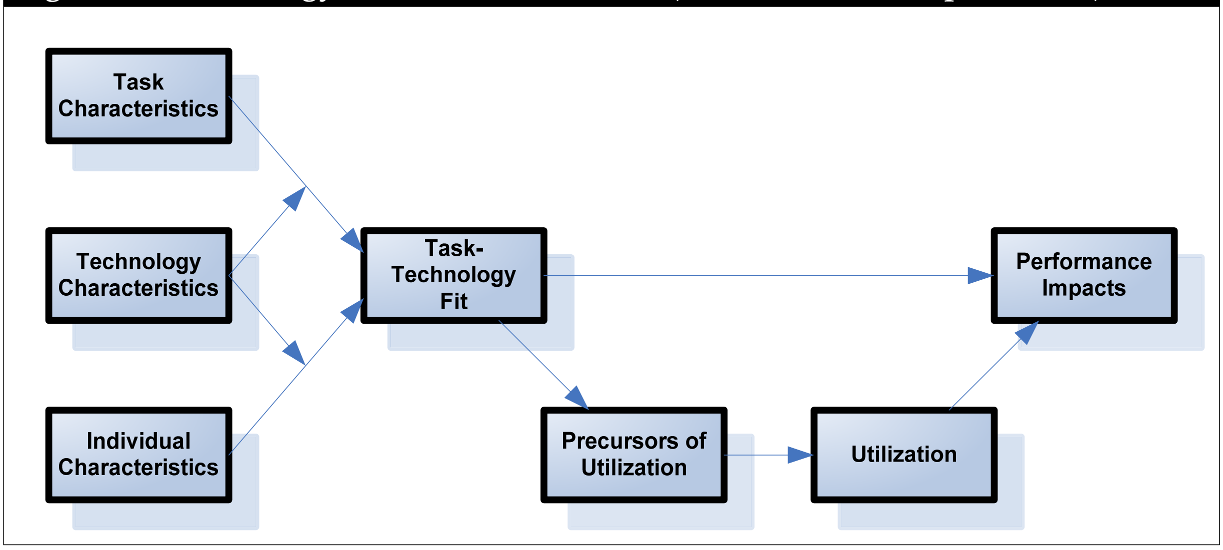
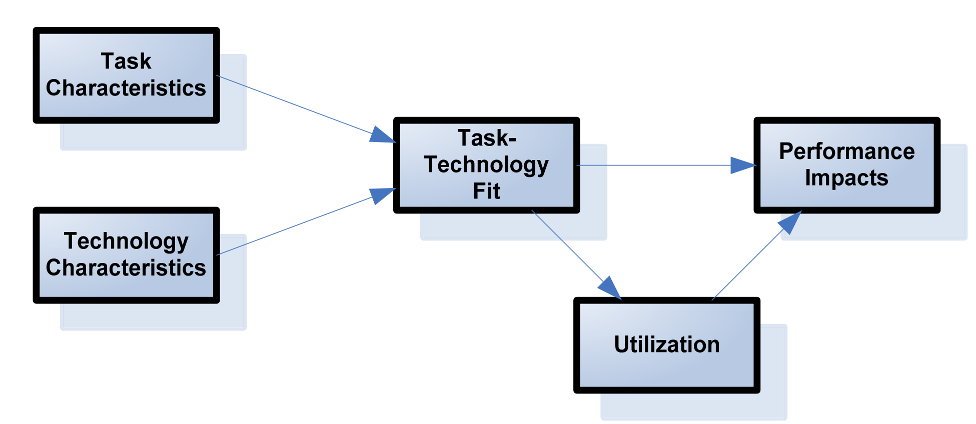


Figure 6 on the next page displays a subset of the TPC model, which is empirically tested in the study of Goodhue & Thompson (1995).

Figure 6 – Subset of TPC to be tested (Goodhue & Thompson, 1995)



Goodhue & Thompson (1995) define the TPC as follows:

Table 4 – TPC Definitions (Goodhue & Thompson, 1995)

Construct	Definition
Task Characteristics	"Tasks are broadly defined as the actions carried out by individuals in turning inputs into outputs. Task characteristics of interest include those that might move a user to rely more heavily on certain aspects of the information technology."
Technology Characteristics	"Technologies are viewed as tools used by individuals in carrying out their tasks. In the context of information systems research, technology refers to computer systems (hardware, software, and data) and user support services (training, help lines, etc.) provided to assist users in their tasks."
Individual Characteristics	"Individuals may use technologies to assist them in the performance of their tasks. Characteristics of the individual (training, computer experience, motivation) could affect how easily and well he or she will utilize the technology."
Task-Technology Fit	"Task-technology fit (TTF) is the degree to which a technology assists an individual in performing his or her portfolio of tasks. More specifically, TTF is the correspondence between task requirements, individual abilities, and the functionality of the technology."
Utilization	"Utilization is the behavior of employing the technology in completing tasks. Measures such as the frequency of use or the diversity of applications employed have been used."
Performance Impacts	"Performance impact in this context relates to the accomplishment of a portfolio of tasks by an individual. Higher performance implies some mix of improved efficiency, improved effectiveness, and/or higher quality."

2.2 Critical Assessment of the Most Influential IS Theories

The overall goal of this thesis is to propose a new unified model that incorporates all relevant existing paradigms as well as their rivals, as stated in the previous sections. In order to achieve this, the consistency of these theories is assessed, as well as the overlap between them. It appears that the theories cannot be compared with each other directly, since there are significant dissimilarities in defining what a construct is and what a measure is. Therefore a new classification is proposed in which all models 'normalize' their components such as constructs and measures. This classification, which is based on Dubin's (1978) *Theory Building,* is used as a blueprint to formulate the new unified model.

2.2.1 The Lack of Consistent Use of Theory Elements

Perhaps one of the most important causes of the inconsistencies and difficulties in comparing different models is the fact that few authors make use of core classifications like: *constructs* and *measures*, or as Dubin (1978) refers to as *units* and *empirical indicators*. Many variations and additions have been used, for example: *characteristics, variables, factors, items,* to refer to (parts of) the models (Davis *et al.*, 1989; Goodhue & Thompson, 1995; Venkatesh *et al.*, 2003). Some authors prefer to use *dimensions* or *categories* as well (DeLone & McLean, 1992).

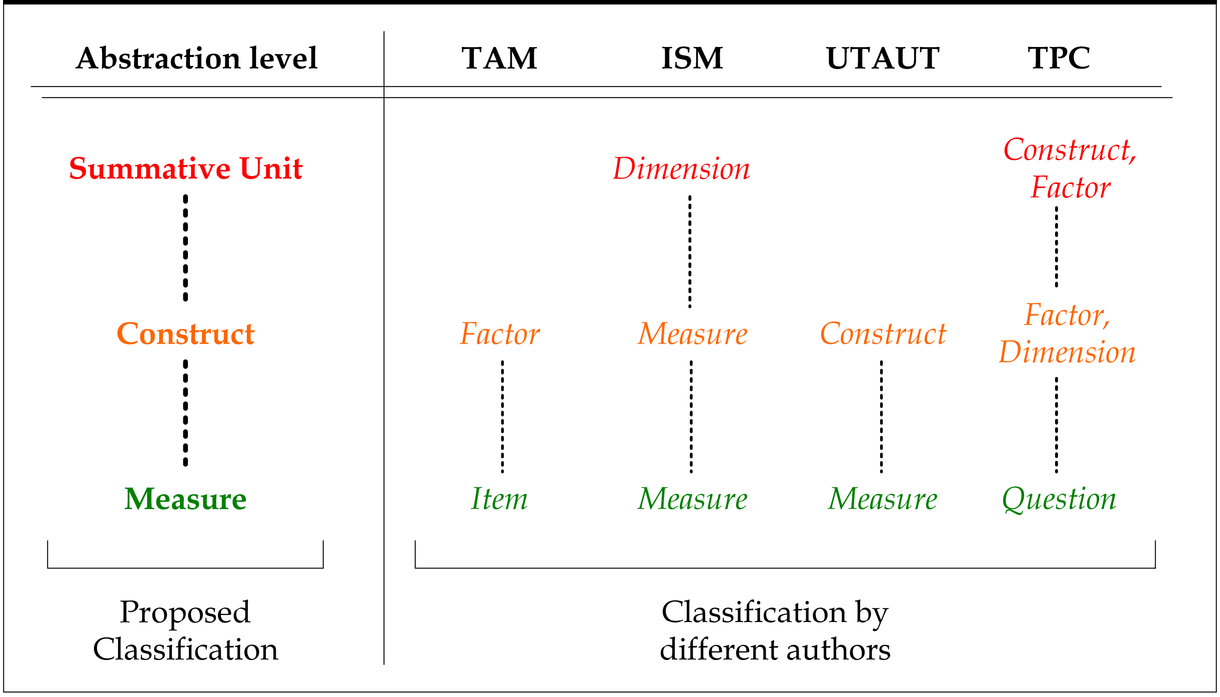
According to Goodhue & Thompson (1995), the Technology-Performance Chain (TPC) is a comprehensive theoretical model that incorporates valuable insights from two complementary streams of research. It highlights the importance of the fit between technologies and user's tasks in achieving individual performance impacts from information technology (Goodhue & Thompson, 1995). Despite these promising words, their article can also be considered as an illustrative example of messing up terms. They use multiple terms to refer to the same thing. For example, in their questionnaire they make a distinction between *constructs* (e.g. TTF), *factors* (e.g. quality), *dimensions* (e.g. currency), and *questions*. To make it even worse, they sometimes use *measures* as well.

Dubin (1969) states "what the necessary and sufficient characteristics are of a theoretical model that will generate empirically testable hypotheses". Among the '7 elements of a theory', he distinguishes between *units* and *empirical indicators*. Furthermore, *summative units* – a specific class of *units* – are defined as:

"A global unit that stands for an entire complex thing. … Analytically a summative unit is one having the property that derives from the interaction among a number of other properties. Without specifying what these other properties are, or without indicating how and under what circumstances they interact, we add them all up in a summative unit. Thus, a summative unit has the characteristic of meaning a great deal, much of which is ill-defined or unspecified." (Dubin, 1969).

As can be seen in figure 7, it appears that only TAM and its 'challenger' UTAUT make use of the comprehensive classification developed by Dubin (1978) of only constructs and measures, whereas the other theories ISM and TPC include summative units as well. To make it even more confusing, Goodhue & Thompson (1995) refer to these summative units as dimensions *and* factors.

Figure 7 – Normalizing Categories



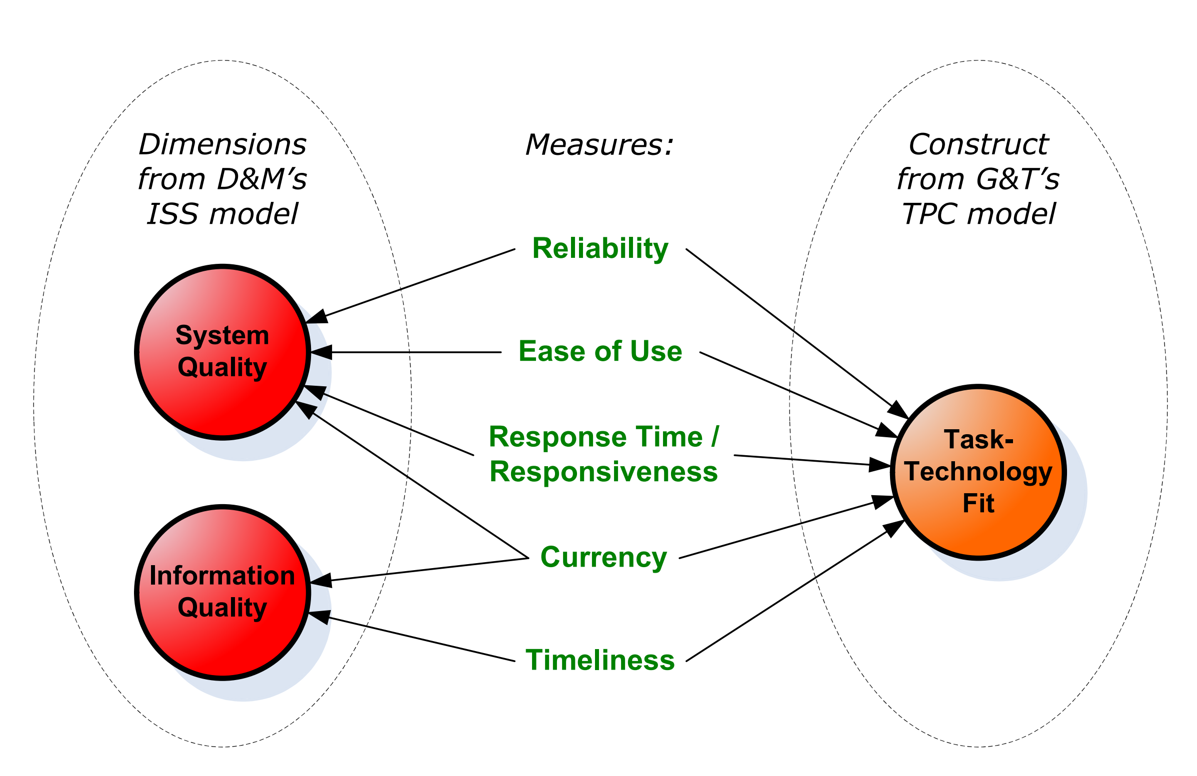
2.2.2 The Lack of Clearly Defined Constructs and Measures

In the early 90s, DeLone & McLean (1992) present a six dimensions taxonomy to organize the diverse research and to present a integrated view on IS success. They summarize all potential measures in one table at the end. DeLone & McLean (1992; 2003) propose *Use* as a dimension or category of the dependent variable *IS success*, but they refuse to specify what they mean by a dimension exactly.

DeLone & McLean (1992; 2003) define *Currency* as a measure of *System Quality* and *Information Quality* simultaneously, while Goodhue & Thompson (1995) claim that *Currency* is a dimension of *Quality*, without specifying exactly what is meant by 'dimension'.

The first mentioned issue about defining one measure to measure multiple constructs affects the construct validity of at least one construct. This causes a serious limitation to the models overall validity. The next figure displays what exactly is meant to be measured by the authors (DeLone & McLean, 1992; 2003) (Goodhue & Thompson, 1995). The figure is a graphical representation of the issues mentioned above – an identical measure to measure different constructs or dimensions.

Figure 8 – Measures used multiple times



When considering response time equal to responsiveness, at least 5 measures are not measuring unambiguously. Moreover, 'currency' is used for 3 measuring purposes.

Concluding, the top IS paradigms are contradicting each other as they are inconsistent in defining the *core* constructs and measures. Remarkably, the conclusion of highly inconsistent definitions among the top IS paradigms was not stated earlier.

2.3 The Need for a Revised and Unified View on IS Success

The fact that the theories mentioned above – who are globally considered as foundations of the information systems discipline (Moody et al., 2009) – are contradicting and inconsistent, as well as the fact that new instruments are potentially much more effective in measuring IS success increases the need for a major iteration in formulating the acceptance model. This 'unification' will be the main subject in the next chapter.

3 Formulation of UTISS

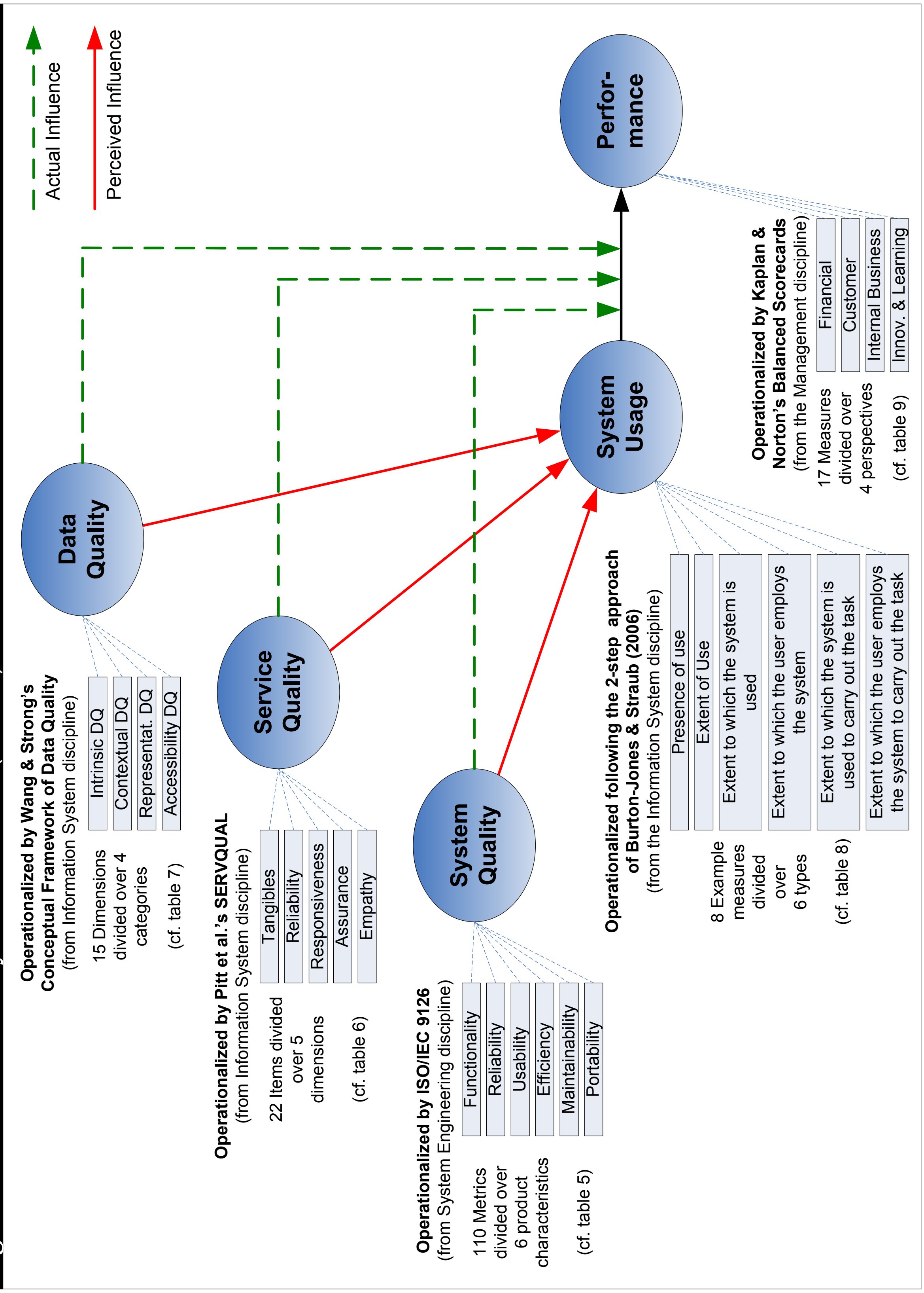
After analysing the leading IS theories as well as stating the major challenges among them, this chapter proposes a unification of these theories by including the determinants of IS success: *System Quality, Service Quality, Data Quality, System Usage,* and *Performance*. After displaying the UTISS model in figure 9, the constructs are defined. Furthermore, this chapter shows that UTISS is consistent with the current IS paradigms, in fact, it goes beyond by improvement of the operationalization of the success model. Well-known and broadly adopted instruments from several other reference disciplines are adopted to measure UTISS' elements:

- ISO/IEC 9126's System Quality standard, originated from the *System Engineering* discipline;
- Pitt et al.'s 22-item SERVQUAL instrument to measure Service Quality, originated from the *Information System* discipline;
- Wang & Strong's conceptual framework of Data Quality, originated from the *Information System* discipline;
- Burton-Jones & Straub's 2-step approach to operationalize System Usage, originated from the *Information System* discipline;
- Kaplan & Norton's Balanced Scorecards to measure Performance, originated from *Management* discipline.

The paragraphs below show a detailed elaboration on each of UTISS' elements. Definitions are given and diagrams of the proposed instruments are shown as well as tables with all potential measures such that the IS researcher can simply choose some measures in order to make the UTISS model sufficiently operationalized to apply in an empirical context.

Finally, the different types of relationships are discussed, i.e. direct versus moderating relationships.

Figure 9 – Unified Theory of IS Success (UTISS)



3.1 System Quality

In order to define *System Quality*, the reference discipline of *System Engineering* is consulted. Originated from this discipline, the ISO9126 (1999) standard defines system quality as: "The totality of characteristics of software product that bear on its ability to satisfy stated and implied needs" (ISO9126, 1999). The standard provides a comprehensive instrument to measure *System Quality* over 6 'characteristics', 27 'sub characteristics' and 110 'metrics'.

Comprehensive specification and evaluation of software product quality is a key factor in ensuring adequate quality. This can be achieved by defining appropriate quality characteristics, taking account of the purpose of usage of the software product. It is important that every relevant software product quality characteristic is specified and evaluated, whenever possible using validated or widely accepted metrics (ISO9126, 1999).

Figure 10 – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)

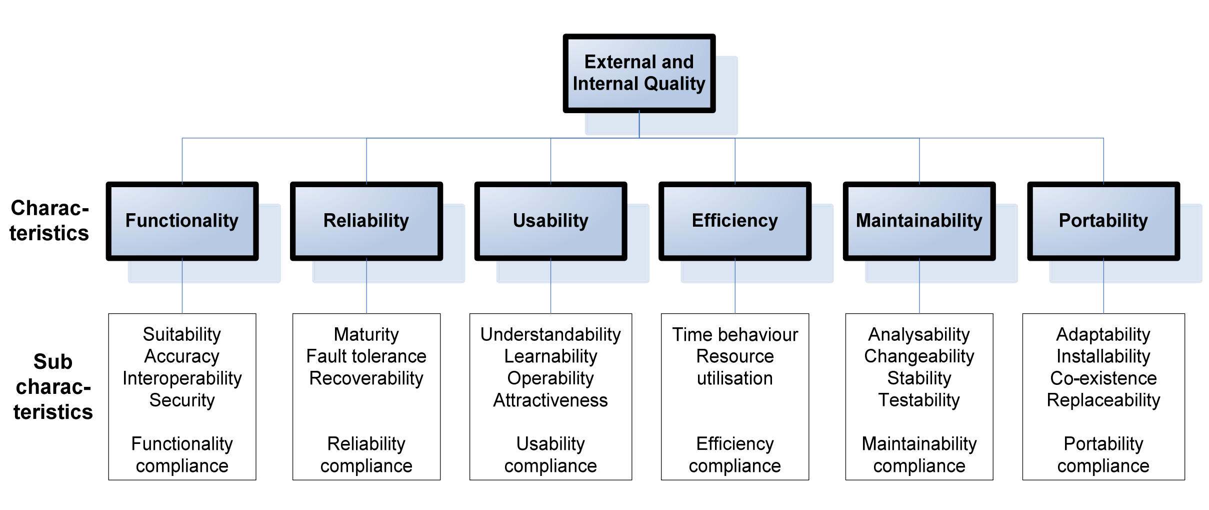


Table 5 below shows the instrument in detail, including the definitions and measures from which an IS researcher can choose to operationalize the UTISS model.

Table 5 – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)

Characteristic	Definition	Sub Characteristic	Definition	Measure
Functionality	"The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions."	Suitability	"The capability of the software product to provide an appropriate set of functions for specified tasks and user objectives."	Functional adequacy
				Functional implementation completeness
				Functional implementation coverage
				Functional specification stability
		Accuracy	"The capability of the software product to provide the right or agreed results or effects with the needed degree of precision."	Accuracy to expectation
				Computational accuracy
				Precision
		Interoperability	"The capability of the software product to interact with one or more specified systems."	Data exchangeability
		Security	"The capability of the software product to protect information and data so that unauthorized persons or systems cannot read or modify them and authorized persons or systems are not denied access to them."	Access auditability
				Access controllability
		Functionality Compliance	"The capability of the software product to adhere to standards, conventions or regulations in laws and similar prescriptions relating to functionality."	Functional compliance
				Interface standard compliance

Table 5 (continued) – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)				
Reliability	"The capability of the software product to maintain a specified level of performance when used under specified conditions."	Maturity	"The capability of the software product to avoid failure as a result of faults in the software."	Estimated latent fault density
				Failure density against test cases
				Fault density
				Fault resolution
				Fault removal
				Mean time between failures
				Test coverage
				Test maturity
		Fault Tolerance	"The capability of the software product to maintain a specified level of performance in cases of software faults or of infringement of its specified interface."	Breakdown avoidance
				Failure avoidance
				Incorrect operation avoidance
		Recoverability	"The capability of the software product to re-establish a specified level of performance and recover the data directly affected in the case of a failure."	Availability
				Mean down time
				Mean recovery time
				Restartability
				Restorability
				Restore effectiveness
		Reliability Compliance	"The capability of the software product to adhere to standards, conventions or regulations relating to reliability."	Reliability compliance

Table 5 (continued) – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)				
Usability	"The capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions."	Under-standa-bility	"The capability of the software product to enable the user to understand whether the software is suitable, and how it can be used for particular tasks and conditions of use."	Completeness of description
				Demonstration accessibility
				Demonstration accessibility in use
				Demonstration effectiveness
				Evident functions
				Function understandability
				Understandable input and output
		Learna-bility	"The capability of the software product to enable the user to learn its application."	Ease of function learning
				Ease of learning to perform a task in use
				Effectiveness of the user documentation and/or help system
				Effectiveness of user documentation and help systems in use
				Help accessibility
				Help frequency
		Opera-bility	"The capability of the software product to enable the user to operate and control it."	Operational consistency in use
				Error correction
				Error correction in use
				Default value availability in use
				Message understandability in use
				Self-explanatory error messages in use
				Operational error recoverability in use
				Time between human error operations in use
				Undoability
				Customizability
				Operation procedure reduction
				Physical accessibility
		Attrac-tiveness	"The capability of the software product to be attractive to the user."	Attractive interaction
				Interface appearance customisability
		Usability Com-pliance	"The capability of the software product to adhere to standards, conventions, style guides or regulations relating to usability."	Usability compliance

Table 5 (continued) – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)				
Efficiency	"The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions."	Time Behavior	"The capability of the software product to provide appropriate response and processing times and throughput rates when performing its function, under stated conditions."	Response time
				Mean time to response
				Worst case response time ratio
				Throughput time
				Mean amount of throughput
				Worst case throughput ratio
				Turnaround time
				Mean time for turnaround
				Worst case turnaround time ratio
				Waiting time
		Resource Utilization	"The capability of the software product to use appropriate amounts and types of resources when the software performs its function under stated conditions."	I/O devices utilisation
				Mean I/O fulfilment ratio
				User waiting time of I/O devices utilisation
				I/O related errors
				I/O loading limits
				Mean occurrence of memory error
				Ratio of memory error/time
				Maximum memory utilisation
				Mean occurrence of transmission error
				Transmission capacity utilisation
				Mean of transmission error / time
				Maximum transmission utilisation
				Media device utilisation balancing
		Efficiency Compliance	"The capability of the software product to adhere to standards or conventions relating to efficiency."	Efficiency compliance

Table 5 (continued) – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)				
Maintaina-bility	"The capability of the software product to be modified. Modifications may include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications."	Analyzability	"The capability of the software product to be diagnosed for deficiencies or causes of failures in the software, or for the parts to be modified to be identified."	Diagnostic function support
				Audit trail capability
				Failure analysis efficiency
				Failure analysis capability
				Status monitoring capability
		Changeability	"The capability of the software product to enable a specified modification to be implemented."	Software change control capability
				Parameterised modifiability
				Modification complexity
				Change cycle efficiency
				Change implementation elapse time
		Stability	"The capability of the software product to avoid unexpected effects from modifications of the software."	Change success ratio
				Modification impact localisation
		Testability	"The capability of the software product to enable modified software to be validated."	Re-test stability
				Availability of built-in test function
				Test restartability
		Maintainability Compliance	"The capability of the software product to adhere to standards or conventions relating to maintainability."	Maintainability compliance

Table 5 (continued) – ISO/IEC 9126 System Quality Standard (ISO9126, 1999)				
Portability	"The capability of the software product to be transferred from one environment to another."	Adaptability	"The capability of the software product to be adapted for different specified environments without applying actions or means other than those provided for this purpose for the software considered."	Adaptability of data structures
				Organisational environment adaptability
				Hardware environmental adaptability
				System software environmental adaptability
				Porting user friendliness
		Installability	"The capability of the software product to be installed in a specified environment."	Ease of installation
				Ease of Setup retry
		Co-existence	"The capability of the software product to co-exist with other independent software in a common environment sharing common resources."	Available co-existence
		Replaceability	"The capability of the software product to be used in place of another specified software product for the same purpose in the same environment."	Continued use of data
				Function inclusiveness
				User support functional consistency
		Portability Compliance	"The capability of the software product to adhere to standards or conventions relating to portability."	Portability compliance

3.2 Service Quality

According to Pitt *et al.* (1995) *Service Quality* is founded on the comparison between what the customer feels should be offered and what is actually provided (Pitt *et al.*, 1995). The authors suggest "SERVQUAL" as an instrument to measure IS service quality. They operationalize this by proposing a 22 item instrument, assessing the subjective side of service. Pitt *et al.* (1995) define *Service Quality* as "the discrepancy between customers' perceptions and expectations". This relationship can be seen in their diagram (figure 11).

Figure 11 – SERVQUAL: Relationship between expected and perceived service (Pitt et al., 1995)

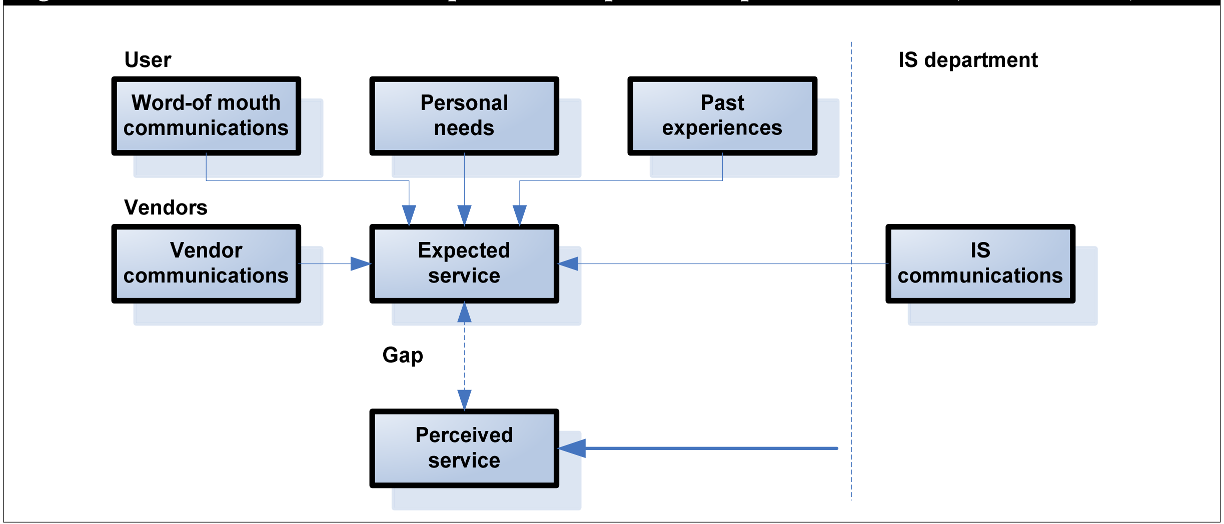


Table 6 below shows the instrument in detail, including the definitions and measures from which an IS researcher can choose to operationalize the UTISS model. Note that "Service Quality for each dimension is captured by a difference score G (representing perceived quality for that item), where G = P - E and P and E are the average ratings of a dimension's corresponding perception and expectation statements respectively" (Pitt *et al.*, 1995).

Table 6 – 22-item SERVQUAL instrument to measure Service Quality (Pitt *et al.*, 1995)

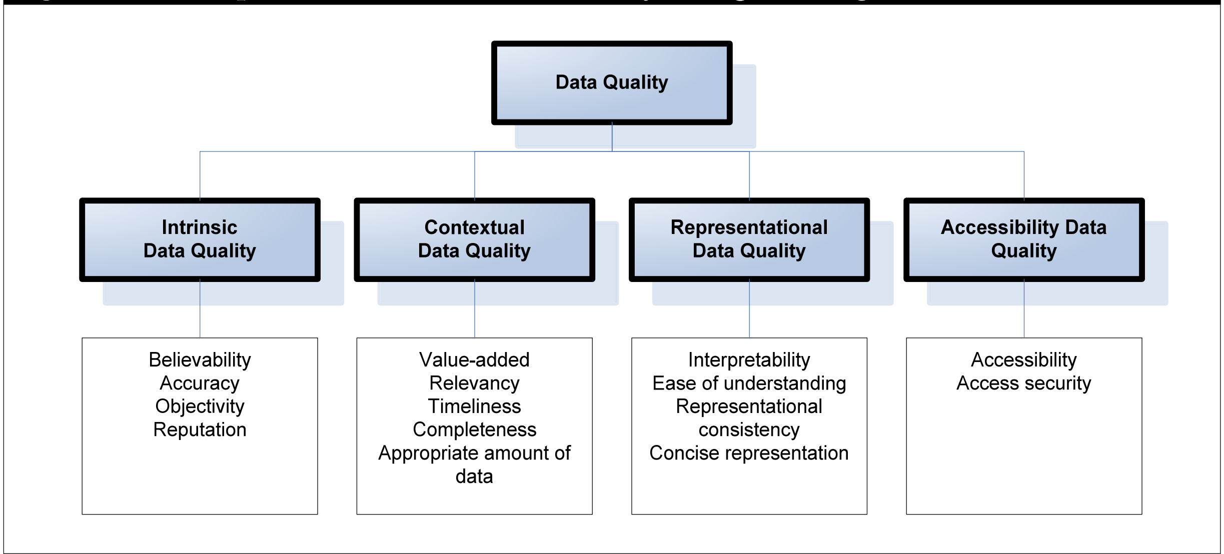
Dimension	**Definition**	**Measurement (Expected)**	**Measurement (Perceived)**
Tangibles	"Physical facilities, equipment, and appearance of personnel."	They will have up-to-date hardware and software.	IS has up-to-date hardware and software.
		Their physical facilities will be visually appealing.	IS' physical facilities are visually appealing.
		Their employees will be well dressed and neat in appearance.	IS' employees are well dressed and neat in appearance.
		The appearance of the physical facilities of these IS units will be in keeping with the kind of services provided.	The appearance of the physical facilities of IS is in keeping with the kind of services provide.
Reliability	"Ability to perform the promised service dependably and accurately."	When these IS units promise to do something by a certain time, they will do so.	When IS promises to do something by a certain time, it does so.
		When users have a problem, these IS units will show a sincere interest in solving it.	When users have a problem, IS shows a sincere interest in solving it.
		These IS units will be dependable.	IS is dependable.
		They will provide their services at the times they promise to do so.	IS provides its services at the times it promises to do so.
		They will insist on error-free records.	IS insists on error-free records.
Respon-siveness	"Willingness to help customers and provide prompt service."	They will tell users exactly when services will be performed.	IS tell users exactly when services will be performed.
		Employees will give prompt service to users.	IS employees give prompt service to users.
		Employees will always be willing to help users.	IS employees are always willing to help users.
		Employees will never be too busy to respond to users' request.	IS employees are never be too busy to respond to users' requests.
Assurance	"Knowledge and courtesy of employees and their ability to inspire trust and confidence."	The behavior of employees will instill confidence in users.	The behavior of IS employees instills confidence in users.
		Users will feel safe in their transactions with these IS units empl.	Users will feel safe in their transactions with IS' employees.
		Employees will be consistently courteous with users.	IS employees are consistently courteous with users.
		Employees will have the knowledge to do their job well.	IS employees have the knowledge to do their job well.
Empathy	"Caring, individualized attention the service provider gives its customers."	These IS units will give users individual attention.	IS gives users individual attention.
		These IS units will have operating hours convenient to all their users.	IS has operating hours convenient to all its users.
		These IS units will have employees who give users personal attention.	IS has employees who give users personal attention.
		These IS units will have the users' best interests at heart.	IS has the users' best interests at heart.
		The employees of these IS units will understand the specific needs of their users.	Employees of IS understand the specific needs of its users.

3.3 Data Quality

According to Wang & Strong (1996) data quality refers to "data that are fit for use by data consumers". To operationalize this construct, the instrument developed by Wang & Strong (1996) can be used. According to the authors, based on their hierarchical framework, a questionnaire could be developed to measure perceived data quality. The data quality categories and their underlying dimensions in this framework would provide the constructs to be measured (Wang & Strong, 1996).

The purpose of Wang & Strong (1996)'s paper is to develop a framework that captures the aspects of data quality that are important to data consumers. They propose a two-stage survey and a two-phase sorting study to develop a hierarchical framework for organizing data quality dimensions. The framework captures dimensions of data quality that are important to data consumers.

Figure 12 – Conceptual Framework of Data Quality (Wang & Strong, 1996)



Their findings are consistent with the understanding that high-quality data should be intrinsically good, contextually appropriate for the task, clearly represented, and accessible to the data consumer. Table 7 below shows the instrument in detail, including the definitions and dimensions from which an IS researcher can choose to operationalize the UTISS model.

Table 7 – Conceptual Framework of Data Quality (Wang & Strong, 1996)			
Category	**Definition**	**Dimension**	**Item**
Intrinsic Data Quality	"Intrinsic data quality denotes that data have quality in their own right."	Believability	"The extent to which data are accepted or regarded as true, real, and credible."
		Accuracy	"The extent to which data are correct, reliable, and certified free of error."
		Objectivity	"The extent to which data are unbiased (unprejudiced) and impartial."
		Reputation	"The extent to which data are trusted or highly regarded in terms of their source or content."
Contextual Data Quality	"Contextual data quality highlights the requirement that data quality must be considered within the context of the task at hand."	Value-added	"The extent to which data are beneficial and provide advantages from their use."
		Relevancy	"The extent to which data are applicable and helpful for the task at hand."
		Timeliness	"The extent to which the age of the data is appropriate for the task at hand."
		Completeness	"The extent to which data are of sufficient breadth, depth, and scope for the task at hand."
		Appropriate amount of data	"The extent to which the quantity or volume of available data is appropriate."
Representational Data Quality	"Representational DQ includes aspects related to the format of the data *(concise* and *consistent representation)* and meaning of data *(interpretability* and *ease of understanding).*"	Interpretability	"The extent to which data are in appropriate language and units and the data definitions are clear."
		Ease of understanding	"The extent to which data are clear without ambiguity and easily comprehended."
		Representational consistency	"The extent to which data are always presented in the same format and are compatible with previous data."
		Concise representation	"The extent to which data are compactly represented without being overwhelming (i.e., brief in presentation, yet complete and to the point)."
Accessibility Data Quality	"Representational data quality and accessibility data quality emphasize the importance of the role of systems: the system must be accessible but secure."	Accessibility	"The extent to which data are available or easily and quickly retrievable."
		Access security	"The extent to which access to data can be restricted and hence kept secure."

3.4 System Usage

According to Davis *et al.* (1989) self-reported measures are often used to operationalize system usage, particularly in cases where objective usage metrics are not available. However, self-reported measures should not be regarded as *precise* measures of actual usage frequency.

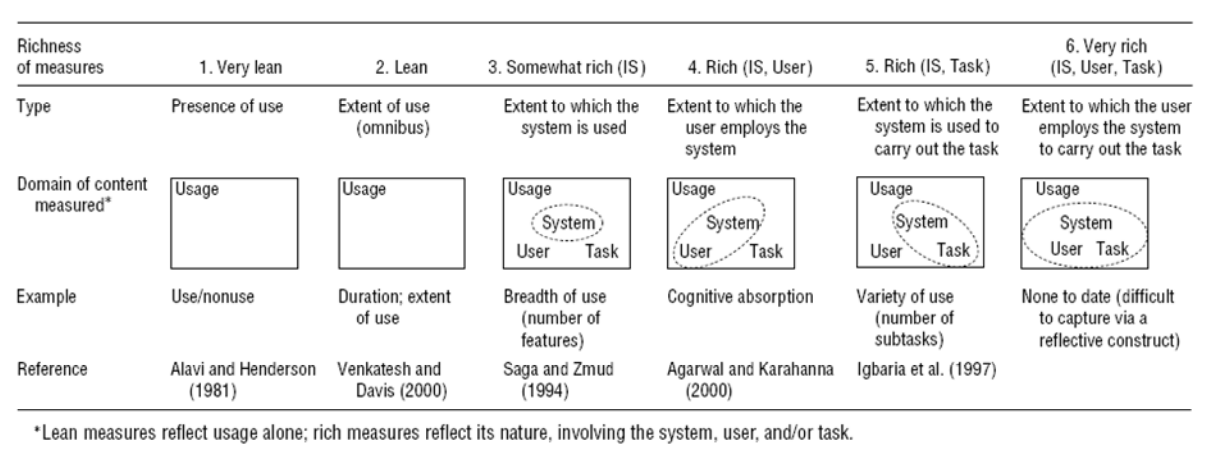
Following the two-step approach of Burton-Jones & Straub (2006), the first step to select usage measures is to define its structure. Because usage involves an IS, user, and task, the relevance of each element should be judged in the light of the theoretical context (Burton-Jones & Straub, 2006).

According to Burton-Jones & Straub (2006), the 'richness' of measures needed to operationalize system usage is dependent of the task at hand. For example simple cognitive activities should be operationalized by rather 'lean' measures of system usage (e.g. duration or extent of use). This is consistent with the measure that is used by Venkatesh *et al.* (2003):

"Actual usage behaviour was measured as duration of use via system logs. Due to the sensibility of usage measures to network availability, in all organizations studied, the system automatically logged off inactive users after a period of 5 to 10 minutes, eliminating most idle time from the usage logs."

In figure 13 Burton-Jones & Straub's conceptualization of lean and rich system usage measures is shown.

Figure 13 – Rich and Lean Measures of System Usage (Burton-Jones & Straub, 2006)



Richness of measures	1. Very lean	2. Lean	3. Somewhat rich (IS)	4. Rich (IS, User)	5. Rich (IS, Task)	6. Very rich (IS, User, Task)
Type	Presence of use	Extent of use (omnibus)	Extent to which the system is used	Extent to which the user employs the system	Extent to which the system is used to carry out the task	Extent to which the user employs the system to carry out the task
Domain of content measured*	Usage	Usage	Usage System User Task	Usage System User Task	Usage System User Task	Usage System User Task
Example	Use/nonuse	Duration; extent of use	Breadth of use (number of features)	Cognitive absorption	Variety of use (number of subtasks)	None to date (difficult to capture via a reflective construct)
Reference	Alavi and Henderson (1981)	Venkatesh and Davis (2000)	Saga and Zmud (1994)	Agarwal and Karahanna (2000)	Igbaria et al. (1997)	

*Lean measures reflect usage alone; rich measures reflect its nature, involving the system, user, and/or task.

Table 8 below shows the instrument in detail, including the definitions and measures from which an IS researcher can choose to operationalize the UTISS model.

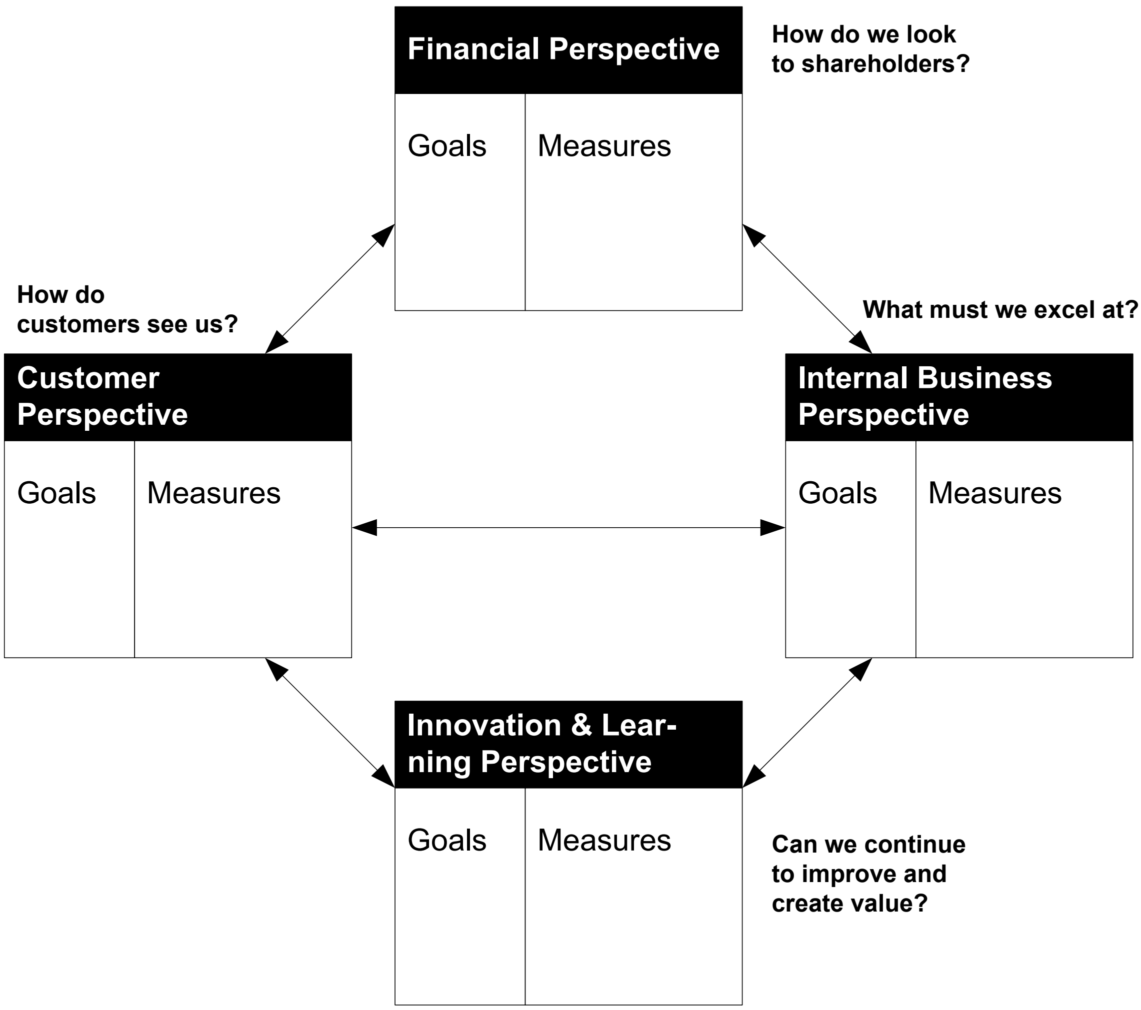
Table 8 – Rich and Lean Measures of System Usage (Burton-Jones & Straub, 2006)		
Type of measure	**Definition**	**Measure (example)**
Presence of use	"Binary variable: the system is used or no used"	Use/nonuse
Extent of use	"The extent of use, e.g. by connect time of hours per week"	Duration
Extent to which the system is used	"Number of systems, sessions, displays, functions, or messages"	Breath of use
Extent to which the user employs the system	Not defined by Burton-Jones & Straub (2006)	Cognitive absorption
Extent to which the system is used to carry out the task	"Number of business tasks supported by the IS"	Variety of use
Extent to which the user employs the system to carry out the task	Not defined by Burton-Jones & Straub (2006)	"None to date (difficult to capture via a reflective construct)"

3.5 Performance

The measures for the Performance construct can be initiated by looking at the "Balanced Scorecard" dimensions suggested by Kaplan & Norton (1992): *customer perspective, financial perspective, internal business perspective*, and *innovation and learning perspective*.

The basic idea of balanced scorecards is that "the evaluation of an organization should not be restricted to a traditional financial evaluation but should be supplemented with measures concerning customer satisfaction, internal processes and the ability to innovate. These additional measures should assure future financial results and drive the organization towards its strategic goals while keeping all four perspectives in balance" (Van Grembergen, 2000). The diagram is shown in figure 14.

Figure 14 – Balanced Scorecard (Kaplan & Norton, 1992))



In their original article, Kaplan & Norton (1992) show some cases of how the balanced scorecard works in practise. They provide some examples of potentially relevant measures, which are displayed in table 9 below.

Table 9 – Balanced Scorecard (Kaplan & Norton, 1992)	
Perspective	**Measure (example)**
Financial perspective	Cash flow
	Sales growth
	Operating income
	Market share
	Return on equity
	Revenue
Internal business perspective	Cycle time
	Unit cost
	Efficiency
	Effectiveness of its product development cycle.
Innovation & learning perspective	Development time
	Process time to maturity
Customer perspective	Percent of sales from new products
	Percent of sales from proprietary products
	On-time delivery
	Number of cooperative engineering efforts
	Equipment up-time percentage
	Mean-time response to a service call.
	Delivery time

Looking at the proposed measures, they may have to be more 'tailored' to the IS context before the construct is appropriately operationalized. Some empirical contexts demand specific metrics to measure performance. One illustrative example is the study of Devaraj & Kohli (2003) in which the authors investigate the relationship between the usage of IT and the organizational performance. To do this, the authors investigate the performance of eight hospitals and define 'mortality' as one of the key performance metrics. Obviously, this metric may be very useful in this setting as it might be very inappropriate in another empirical setting. Although this holds for the proposed balanced scorecard dimensions as well, the perspectives might be relevant and triggering in coming up with appropriate measures to operationalize the Performance construct.

3.6 Perceived versus Actual Influence

In the conceptual model a distinction has been made between perceived and actual influence (respectively indicated by the solid red and dotted green arrows in figure 9). The quality perceptions are hypothesized to impact system usage directly, whereas the actual (or objective) quality of systems, services, and data are hypothesized to influence the actual organizational performance of the information system in a moderating way.

As an example, someone might think that a particular information system is of 'good' quality because colleagues or salesmen told him it is easy to learn (as *ease of learning* is one of the quality measures indicated by the ISO standard, table 5). Because of his positive *perception*, this person will be happy to use the IS. However, it might be that the *actual* system quality (when measured and compared with other similar IS) is not that good at all. This will obviously have an impact on the IS implementation's ROI, because more time and effort are invested in learning to operate the IS.

3.7 UTISS' Consistency with the Most Influential IS Theories

The purpose of this paragraph is to show that UTISS is consistent with the most influential IS theories as stated before. This paragraph also explains why certain (parts of the) theories are left out.

3.7.1 UTISS' Consistency with TAM

In his investigation, Davis (1989) developed and validated measurement scales for *perceived usefulness* and *perceived ease of use*, TAM's core constructs. The measurements he proposed (carried out in the form of a questionnaire) are displayed in table 10. To show how UTISS incorporates these measures, they are mapped on ISO9126's System Quality instrument.

Table 10 - UTISS' Consistency with TAM

Davis' TAM Constructs	Davis' TAM Measures	ISO9126's System Quality
Perceived Usefulness	Work more quickly	Efficiency
	Job performance	Efficiency
	Increase productivity	Efficiency
	Effectiveness	Suitability
	Makes job easier	Usability
	Useful	Usability
Perceived Ease of Use	Easy to learn	Learnability
	Controllable	Usability
	Clear & understandable	Understandability
	Flexible	Portability
	Easy to become skillful	Learnability
	Easy to use	Understandability

Concluding, all of the measures proposed by Davis (1989) to measure TAM's constructs *usefulness* and *ease of use* are covered by the instrument of ISO9126.

3.7.2 UTISS' Consistency with ISM

As stated earlier, DeLone & McLean (1992) still possess a major position in the IS discipline. As many IS researchers take their taxonomy as a point of departure, this thesis will assess its consistency as well. The following table shows a systematic 'bottom-up' evaluation of the ISM model, in order to determine what is to be used in formulating the new unified model later on.

While their original IS Success Model was confusing because "DeLone & McLean (1992) attempted to combine both process and causal explanations of IS Success in their model" (Seddon, 1997), their 10 years update unfortunately still contains the ambiguous semantics of the notations and arrows. For example: what does it mean that the *Intention to Use* and *Use* constructs are connected to each other? Is there a hidden (causal) arrow underneath, or should the constructs be merged? It is unclear what is exactly meant by this exotic convention.

One of the main complaints about DeLone & McLean's (1992; 2003) taxonomy of IS success is that it is not operationalized such that it can be used by practitioners. While the authors claim they provide a comprehensive taxonomy with "measures of IS success", most of the proposed 'measures' are in fact 'constructs'. To prove this, the following table shows the aforementioned constructs (second column) which are presented by DeLone & McLean

(1992) as "TABLE 1 – Empirical Measures of System Quality" and "TABLE 2 – Empirical Measures of Information Quality".

The "Service Quality" dimension is not mentioned in their original paper from 1992, as it is adopted almost literally from Pitt *et al.* (1995) in their "Ten Years Update" (DeLone & McLean, 2003). Therefore the 'connection' between the dimension and the instrument is 100%.

Table 11 - UTISS' Consistency with ISM

DeLone & McLean's ISM 'Dimensions'	DeLone & McLean's ISM 'Measures'	ISO9126's System Quality	Wang & Strong's Data Quality	Pitt et al.'s SERVQUAL
System Quality	Investment utilization	Efficiency		
	Reliability	Reliability		
	Ease of Use	Usability		
	Learnability	Ease of Learning		
	Convenience	Attractiveness		
	Flexibility	Portability		
	Integration	Interoperability		
	Response time	Time behaviour		
	Error rate	Fault tolerance		
	(Perceived) usefulness	-		
	IS sophistication	-		
	System accessibility	-		
Information Quality	Accuracy		Accuracy	
	Timeliness		Timeliness	
	Completeness		Completeness	
	Conciseness		Concise	
	Format		Represent. consistency	
	Relevance		Relevancy	
	Understandability		Ease of understanding	
	Freedom from bias		Objectivity	
	Quantitativeness		Amount of data	
	Precision		-	
	Currency		-	
	Reliability		-	
	(Perceived) usefulness		-	
	(Perceived) importance		-	
	Sufficiency		-	
	Comparability		-	
Service Quality	Tangibles			Tangibles
	Reliability			Reliability
	Responsiveness			Responsiveness
	Assurance			Assurance
	Empathy			Empathy

Concluding, 24 out of the 34 constructs proposed by DeLone & McLean's (1992) IS Success Model are 'covered' by the three proposed instruments by ISO9126 (1999), Wang & Strong (1996), and by Pitt *et al.* (1995), in such a way that the dimension is finally operationalized and hence can be used by IS researchers.

3.7.3 UTISS' Consistency with UTAUT

Except for the construct *behavioral intention to use*, most of UTAUT's measures are captured by UTISS proposed instruments, as can be seen in the following figure.

Table 12 - UTISS' Consistency with UTAUT

Venkatesh' UTAUT Constructs	Venkatesh' UTAUT Measures	ISO9126's System Quality	Pitt et al.'s SERVQUAL	Burton-Jones & Straub's System Usage
Performance Expectancy	Usefulness	Usability		
	Accomplish tasks more quickly	Efficiency		
	Productivity	Efficiency		
	Chance of getting raise	-		
Effort Expectancy	Understandable interaction with IS	Understandability		
	Easy to become skillful	Learnability		
	Easy to use	Understandability		
	Easy to learn	Learnability		
Facilitating Condidions	System compatibility	Portability		
	Presence of assistance		Responsiveness	
	Necessary resources		-	
	Necessary knowledge		-	
Social Influence	Organizational support for using the system		Responsiveness	
	People who influence my behavior think that I should use the system		-	
	People who are important to me think that I should use the system		-	
	Senior mgt. has been helpful in the use ot the system		-	
Behavioral Intention to Use	Intention to use			
	Prediction to use			
	Planning to use			
Use behavior	Duration of use via system logs			Extent of use (duration)

Thus, except for one construct, UTISS is consistent with UTAUT.

3.7.4 UTISS' Consistency with TPC

TPC's main construct *Task-Technology Fit* is for the largest part covered by other instruments and therefore the need to include this construct into the success model is eliminated. The other constructs of TPC are not operationalized.

Table 13 - UTISS' Consistency with TPC

Goodhue & Thompson's TPC Constructs	Goodhue & Thompson's TPC Measures	ISO9126's System Quality	Wang & Strong's Data Quality	Pitt et al.'s SERVQUAL
Task-Technology Fit	Reliability	Reliability		
	Ease of use	Usability		
	Training	Usability		
	Right data		Data accuracy	
	Right level of detail		Relevancy	
	Authorization		Access security	
	Timeliness		Timeliness	
	Responsiveness			Responsiveness
	Compatibility			
	Currency			
	Locatability			
	Meaning			
	IS understanding of business			
	Consulting			
	IS performance			
Task Characteristics	Task equivocality			
	Task interdependence			
Performance Impacts	Performance impact of computer systems			
Technology Characteristics				
Individual Characteristics				
Utitilization				

3.7.5 The Exclusion of User Satisfaction

Bailey & Pearson (1983) provide a technique for measuring and analyzing computer user satisfaction. They state that "measuring and analyzing computer user satisfaction is motivated by management's desire to improve the productivity of information systems. It is well recognized that productivity in computer services means both efficiently supplied and effectively utilized data processing outputs. Further, it is argued that utilization is directly connected to the user community's sense of satisfaction with those services" (Bailey & Pearson, 1983).

DeLone & McLean (1992; 2003) adopt this construct (or 'dimension' as they refer to it) and propose it to be a key antecedent of *Individual Impact* (or *Net Benefits* in their updated version) and *System* Usage. However, looking at the list of factors Bailey & Pearson (1983) claim to be most affecting user satisfaction, it is highly questionable whether this construct has the right to exist. For example, looking at the "five most important factors" in table 14, the top 4 out of 5 factors are incorporated in other models: *Accuracy, Timeliness,* and *Relevance* are part of Wang & Strong's Data Quality whereas *Reliability* is part of ISO9126's System Quality.

Table 14 – Factors that affect User Satisfaction (Bailey & Pearson, 1983)

Five Most Important and Five Least Important Factors

Most Important	Least Important
1. Accuracy	1. Feeling of control
2. Reliability	2. Volume of output
3. Timeliness	3. Vendor support
4. Relevancy	4. Degree of training
5. Confidence in System	5. Organizational position of EDP

This means the strongest arguments to adopt the construct *User Satisfaction* in a success model are not valid anymore. Thus, this construct excluded from the UTISS model since its 'core' is already covered by other instruments.

4 Empirical Validation of UTISS

This chapter shows how the UTISS model can be operationalized and applied to specific IS cases. In other words, this chapter is an example of how IS researchers could use the UTISS model in future to explain and predict the success of IS implementation projects.

Furthermore, this chapter discusses the methodology that is used as well as the cases.

Similarly to the previous chapter, in which the 'general' model is shown and described, now the applied model is displayed. This applied model is a subset of the generic model: the choices that are made are clearly indicated by the difference in colours (black versus grey). The rationale behind these choices in operationalizing the UTISS model is given in paragraph 4.3.

4.1 Methodology

This paragraph presents the research approach, methods, and techniques that are used during this thesis.

4.1.1 Qualitative versus Quantitative Research

For the empirical part, qualitative interviews are used to validate the model in multiple settings. During these interviews – which are extensively described in chapter 5 – objective quantitative data is derived from archival records and system print-outs.

This method is chosen as primary data collection method because (1) it is suitable to derive comparable data across subsets of the chosen sample to discover similarities and differences and (2) because of its versatility, that is, all types of information can be gathered by questioning others.

This method is neither pure qualitative (because no extensive corroboration was carried out) nor quantitative (because only 3 cases are selected). Despite the potential limitations this may cause for quantitative statistical methods, this approach is still very useful for assessing the appropriateness and feasibility of the proposed model. Besides this, the availability of the proposed data items can be determined rather easily.

A pilot-test is carried out to assess the availability of the needed data and hence to assess the feasibility of the model. In the discussion section of this thesis it is suggested to extensively test this model more formal (i.e. more cases) in future.

It is assumed that the developed items are based on largely available data, or at least that the data can be made available easily. The feasibility of these items and requested data is assessed during the preliminary interviews. If for some reason the requested data is not available and cannot be made available, the reason is used to contribute to the conclusion section. For example, if it appears that companies do not gather key performance and usage data consciously, it is a valuable suggestion to do so in future.

4.1.2 Longitudinal versus Cross-sectional Data Collection

Since information system usage will be purely based on objective actual system usage, Straub *et al.* (1995) view this as an opportunity to gather voluminous longitudinal data and that it therefore permits researchers to go beyond cross-sectional research.

Similarly, Devaraj & Kohli (2003) state that using a technology might not only vary across organizations but also between different time periods for the same organization. Therefore, they consider a cross-sectional set of organizations combined with time-series data ideal to examine the effect of the actual usage on performance (Devaraj & Kohli, 2003).

Considering this research' empirical settings and IT artefacts, it is unfortunate that such an extensive longitudinal approach is rather impossible due to the fact that the information systems were implemented just recently. Selecting a representative period-of-analysis (without including the learning period) was a challenge in its own, let alone selecting multiple periods. However, a longitudinal comparison between pre-implementation and post-implementation was realistic, e.g. for the FTE's needed to process the invoice processing tasks. Conclusions derived from this 'modest' longitudinal analysis are drawn accordingly.

4.1.3 Data Analysis

As mentioned earlier, formal statistical methods to analyze the data is unfortunately impossible due to the limited number of cases. Instead, some descriptive techniques will be used to analyze and present the data.

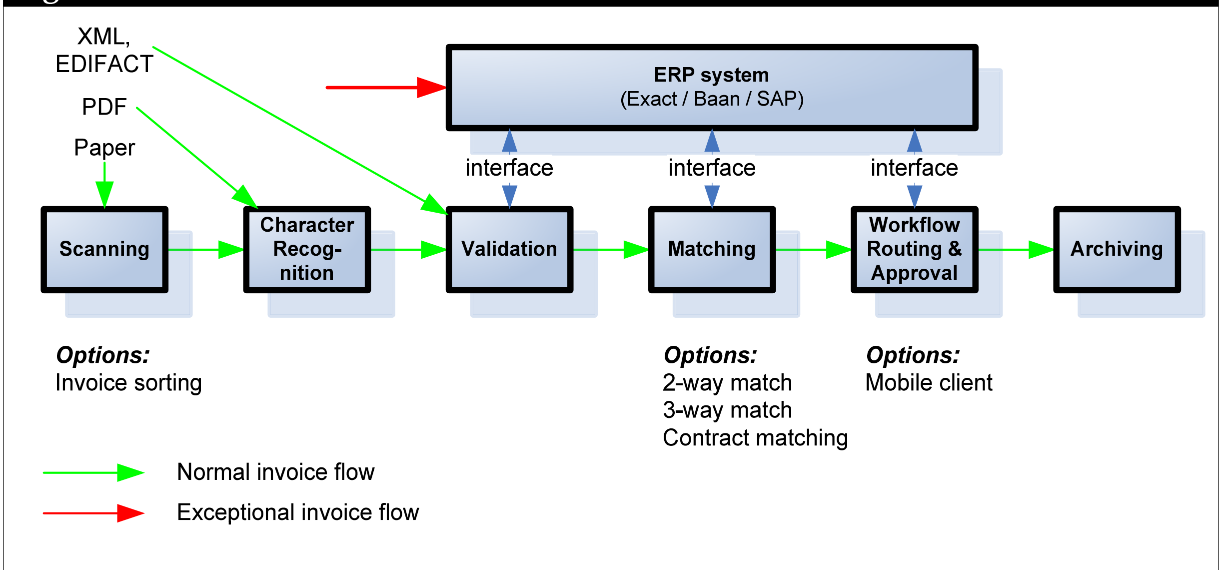
4.2 Description of the Information System

The investigated information system in this thesis is invoice automation. An overview of this process is displayed in the figure below:

Figure 15 – Overview of the Invoice Automation Process

Different functions are available – by some vendors referred to as modules (BasWare, 2009). A more detailed picture of the possibilities is displayed in the next chart:

Figure 16 – Modules of Invoice Automation



The 'shared-service centre case' had multiple entities and therefore they sort the invoices per entity. This is considered outside the automated invoice process for comparison purposes – the other cases have only one entity.

4.2.1 Scanning & Recognition: paper versus digital invoices

The Dutch State Secretary of Finance De Jager recently simplified the administrative and invoicing requirements in the VAT legislation (Jager, 2009). In short, the electronic invoice will be considered equivalent to a paper invoice. Vendors of invoice automation offer the possibility to process both formats. Actually there are 3 formats: paper, digital in PDF, and digital in other sophisticated text formats such as XML and EDIFACT. Recognition by "Optical Character Recognition" is not applicable for the latter format, since these formats already consists readable text characters.

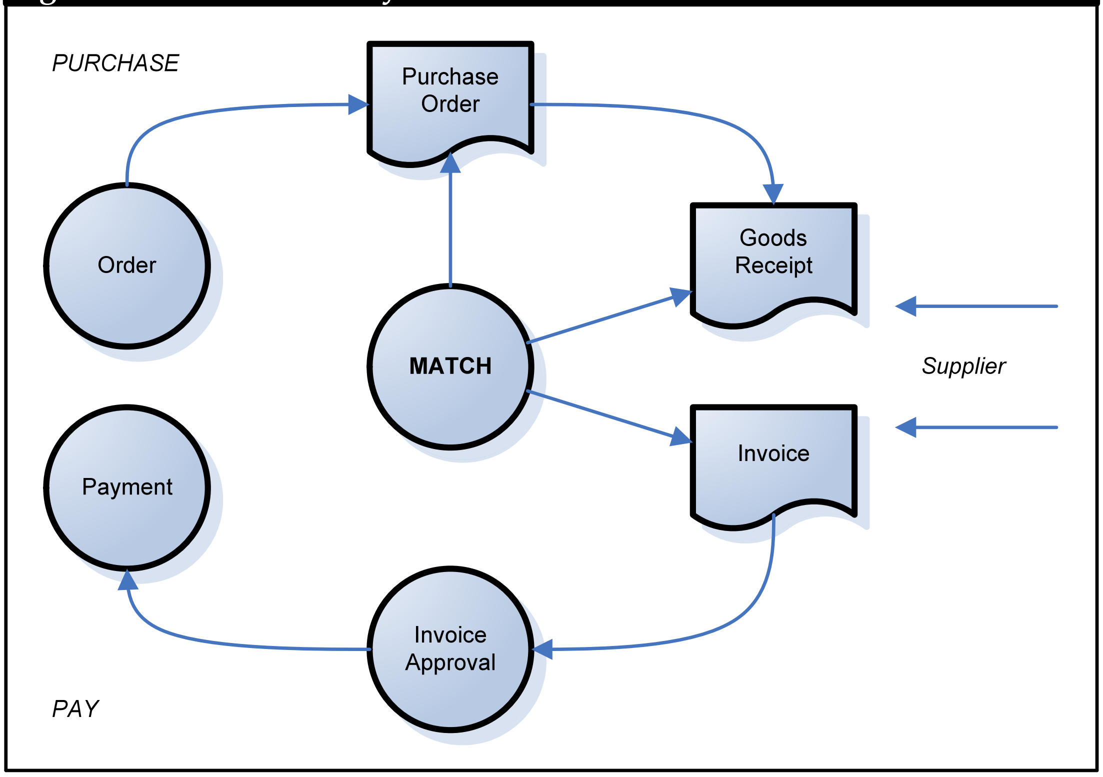
4.2.2 Validation

Validation refers to the verification of e.g. invoice number, VAT (in Dutch: BTW) number, total amount of the invoice with the ERP database.

4.2.3 Matching

Several matching methods are available and while at least one of them is essential in the automated invoice process, an organization can choose for one or more methods. In short, the 2-way method matches the invoice with the purchase order whereas the 3-way method has an additional match with the goods receipt (cf. figure 17).

Figure 17 – Purchase to Pay Process



The contract matching module automates the processing of periodic or contract-based purchase invoices. The system automatically matches the invoice with the contract or payment schedule and transfers the matched invoices directly to the accounts payable system for payment. In all cases, if the invoice does not match, it is automatically coded and sent to the authorized person for approval (so-called 'routing').

4.2.4 Workflow Routing, Approval & Archiving

If there is a match (2-way, 3-way or contract), the invoice will be offered to the ERP system via an interface. Additionally, depending on the format of the invoice (paper or digital), the invoice will be stored physically in an archive or digitally in a database. If there is a mismatch, the routing module notifies the appropriate employee or manager for approval. This can also take place on a remote location if the option "mobile client" is available.

4.3 The Empirical Research Model

The constructs are derived from the UTISS conceptualization in the previous chapter and they are operationalized by using appropriate measurements. In other words, the model presented in figure 18 is a subset of the generic UTISS model.

4.3.1 System Quality

From the ISO9126 (1999) framework, appropriate constructs and measures are chosen based on the available data in the empirical settings. Helpdesk support requests and ease of learning seemed reasonable and feasible to use in this context. ISO9126 (1999) suggests the following measures: the number of times helpdesk support was asked and the number of training hours a clerk needs to perform their invoice processing tasks sufficiently well.

Another measure, although only available at one company, is uptime of the system.

4.3.2 Service Quality

This summative unit is hypothesised to consist of helpdesk response time and problem repetitiveness. These constructs are measured by the average response time of the helpdesk and the number of problems that re-occurred within a certain time period.

4.3.3 Data Quality

In the perspective of the empirical setting, it is difficult and not unambiguous to define what data quality exactly means. Data quality in this context is defined as the correctness of the invoices to be processed. Therefore this umbrella term is operationalized by the number of incorrect invoices offered by vendors as a percentage of the total number of invoices offered by vendors.

4.3.4 System Usage

Considering the tasks at hand – processing invoices – it seems more appropriate to look at *the number of tasks performed* rather than the duration of usage, which is common in IS research. To meet with Burton-Jones & Straub (2006)'s requirements to measure system usage multi-dimensionally, another metric was used: *the number of functions used.* What these functions exactly entail will be discussed later on.

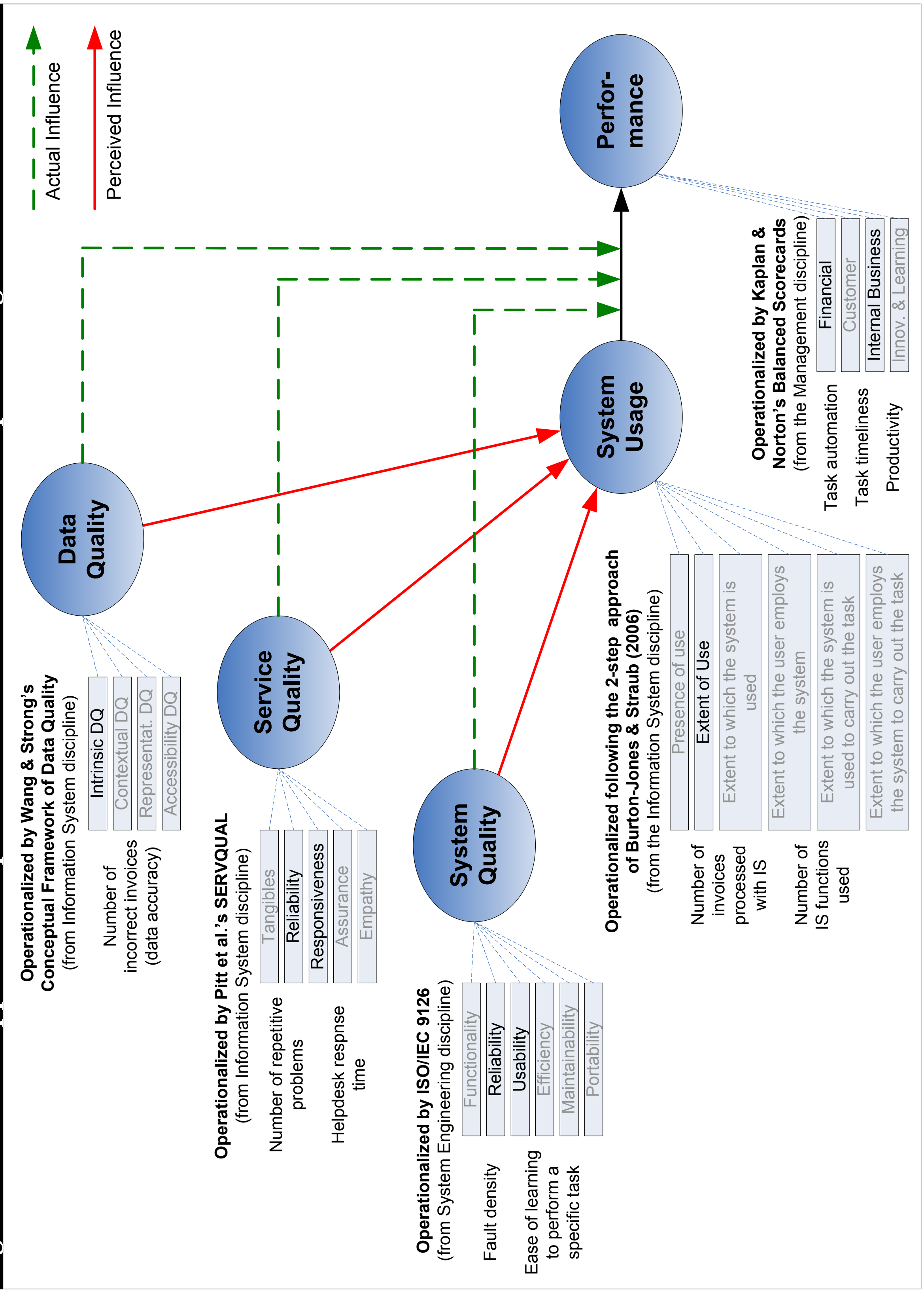
4.3.5 Performance

Looking at Kaplan & Norton's balanced scorecard dimensions, the *financial* and *internal business dimensions* seem the most appropriate to apply in this empirical context. The constructs task automation, task timeliness, and productivity are hypothesized to be positively influenced by system usage. These constructs are measured as followed:

- The number of invoices paid too late (or as suggested by one of the organizations: the leadtime per invoice).
- The number of lost invoices.
- Optical Character Recognition (OCR) percentages.
- Number of FTE's used to perform all invoice-processing tasks.
- 2 (or 3)-way matching percentages.

The next diagram displays the research model that is tested empirically, in three different settings (which will be described later on).

Figure 18 – UTISS applied to empirical context: automated invoice processing



4.4 Research Hypotheses

From the empirical model in the previous section, the following hypotheses are drawn:

4.4.1 Direct (perceived) relationships

H1: The number of helpdesk support requests will negatively influence system usage.

H2: Ease of learning will positively influence system usage.

H3: Helpdesk response time will negatively influence system usage.

H4: Problem repetitiveness will negatively influence system usage.

H5: Data accuracy will positively influence system usage.

H6: System usage will positively influence task automation.

H7: System usage will positively influence task timeliness.

H8: System usage will positively influence the employees' productivity.

4.4.2 Moderating (actual) relationships

H9: The influence of system usage on task automation will be moderated by the number of helpdesk requests and ease of learning, such that the effect will be stronger when helpdesk support requests are low, particularly when the system is easy to learn.

H10: The influence of system usage on task automation will be moderated by helpdesk response time and problem repetitiveness, such that the effect will be stronger when helpdesk response time is low, particularly when problem repetitiveness is low.

H11: The influence of system usage on task automation will be moderated by data accuracy, such that the effect will be stronger when the data is accurate.

H12: The influence of system usage on task timeliness will be moderated by the number of helpdesk requests and ease of learning, such that the effect will be stronger when helpdesk support requests are low, particularly when the system is easy to learn.

H13: The influence of system usage on task timeliness will be moderated by helpdesk response time and problem repetitiveness, such that the effect will be stronger when helpdesk response time is low, particularly when problem repetitiveness is low.

H14: The influence of system usage on task timeliness will be moderated by data accuracy, such that the effect will be stronger when the data is accurate.

H15: The influence of system usage on productivity will be moderated by the number of helpdesk requests and ease of learning, such that the effect will be stronger when helpdesk support requests are low, particularly when the system is easy to learn.

H16: The influence of system usage on productivity will be moderated by helpdesk response time and problem repetitiveness, such that the effect will be stronger when helpdesk response time is low, particularly when problem repetitiveness is low.

H17: The influence of system usage on productivity will be moderated by data accuracy, such that the effect will be stronger when the data is accurate.

Besides of being interesting for the body of knowledge (Davis, 1971), these hypotheses are parsimonious, falsifiable and useful for practice. These criteria are defined by Sutton & Staw (1995) as determinants for a good theory.

5 Data Analysis & Discussion

In this chapter, the data derived via interviews and system-reports are presented, analysed, and the results are summarized. The data is derived from three cases and therefore no sophisticated statistical techniques can be used. However, to draw some qualitative conclusions, a comprehensive descriptive table is presented (cf. table 18). This table serves as a foundation for another conclusive table: a mapping of findings onto the hypotheses (cf. table 19).

5.1 Results Case 1 – The Internet Foundation

The first organization is a foundation that is responsible for the distribution and development of internet domains. The organization processes approximately 2000 invoices annually, for which currently 1 person (0,8 FTE) is hired. Their most important arguments supporting the business case for implementing an automated invoice processing system were quality improvements (for example always knowing the status of an invoice) and increasing the ease-of-use of the invoice-processing tasks.

A secondary and less important argument for implementing the information system was the efficiency improvement. Efficiency improvements (approximately 15%) are realized by (a) spending less time on errors like lost invoices and (b) spending less time on approving invoices since the manager is able to approve from a remote location electronically. The 0,8 FTE which is assigned to process these tasks will remain despite the decreasing demands of the invoice-processing tasks. The realized reductions enable to add additional tasks to the employee that is hired to process the invoices.

Concerning the invoice process, since this organization processes invoices largely concerning delivered services instead of tangible goods, the traditional 'goods receipt' is replaced by a confirmation step that the requested services are indeed delivered.

5.1.1 Interview Description

The interview took place on the 7th of April 2009, with the controller of the organization. The interview was recorded by using a voice recorder. Afterwards, additional questions were posed by telephone.

5.1.2 Obtained Data

The table below is a summary of the data derived from the interview and telephone call. The constructs system usage and performance can result in "pre-IS" and "post-IS" data whereas the constructs system quality, service quality, and data quality can only result in "post-IS" data, since the data is about the information system.

Table 15 – Results Case 1	
General	
Function / Role	Manager Control & Support
ERP system	Multivers is substituted by Exact Globe
Invoice Automation	eSynergy
Date of implementation	Exact Globe: Approx. 1/7/2008 eSynergy: Approx. 1/1/2009
Pre-implement. period "Pre-IS"	1/6/2008 – 1/1/2009 (= 0,5 year)
Post-implementation period "Post-IS"	1/1/2009 – 1/4/2009 (= 0,25 year)
System Quality	
Number of times helpdesk support was requested.	Post-IS: 20 times = 15 times in-house IT department + 5 times external helpdesk support (eSynergy).
Number of training hours needed to operate the system.	2 days = 16 hours
Other suggested measures	In future issues will be logged in order to formulate suggestions to improve system quality.
Service Quality	
Number of times helpdesk support was requested.	Post-IS: 20 times = 15 times in-house IT department + 5 times external helpdesk support (eSynergy).
Average response time to help requests (i.e. average time that the problem was solved).	Data are not recorded, dependent on the type of problem.
Number of repetitive problems.	Post-IS: 5 times of the 20 times mentioned earlier.
Other suggested measures.	None.
Data Quality	
Total number of processed invoices.	Pre-IS: 1.000 (during 0,5 year) Post-IS: 500 (during 0,25 year)
Number of incorrect invoices, delivered by the vendors.	Post-IS: 30 However, there is no difference with previous years.
Other suggested measures.	None.
System Usage	
Total number of processed invoices.	Pre-IS: 2.000 (during 0,5 year) Post-IS: 500 (during 0,25 year)
Number of invoices processed by the automated invoice processing system.	Pre-IS: 0 Post-IS: 500 – 2 incidents = 498 2 invoices are processed manually due to incidents (which are probably starting-up problems).
Number of IS functions used.	Post-IS: 5 functions → scanning, matching, archiving, assigning additional items, and remote approval of invoices.
Other suggested measures.	None.
Performance	
Number of times the invoice is processed incorrectly (e.g. lost documents)?	Pre-IS: Data are not recorded. Post-IS: 0 → No invoices disappeared since the information system was implemented.
Number of invoices processed too late.	Pre-IS: Data are not recorded. Post-IS: Data are not recorded.
Number of FTE's needed to process all invoices.	Pre-IS: 0,8 FTE Post-IS: 0,65 FTE The 0,15 FTE reduction is captured by assigning other tasks to the employee.
Other suggested measures.	None.

5.1.3 Preliminary Conclusion

Looking at the data, it appears that by far not all suggested items are recorded. Even the points on which the business case was written – i.e. quality improvements such as reducing the number of lost invoices – are not recorded formally. Still, efficiency improvements are visible, even in this early stage (from 0,8 to 0,65 FTE).

An important limitation might be that the system in this case is operational for only 3 months. Therefore, this period may not be very representative since the learning effect is very strong in the beginning of IT projects.

5.2 Results Case 2 – The Manufacturing Company

This case is about a manufacturer of central heating systems, which develops, builds, and markets high-efficiency boilers in which they are the market leader in the Netherlands.

Concerning the invoice process, all invoices (even receipts without purchase orders) are offered to the system and therefore not all cases will pass the check. This check consists of 3-way matching in which the purchase order will be compared with the goods receipt and the invoice. If the differences in the numbers are within the margin (e.g. due to variance in currency), the matching is considered OK. The system automatically checks the calculations as well (such as totals, VAT, etc). Another criterion of the check is the presence of the bank account in the ERP system.

5.2.1 Interview Description

The interview took place on the 19th of May 2009, with the internal accountant of the organization. Unfortunately the interviewee did not want the interview to be recorded. During the interview, a computer with reporting tools was available to derive and present relevant data.

5.2.2 Obtained Data

The table below is a summary of the most important data derived from the interview. The constructs system usage and performance can obtain data before and after the automated invoice processing system was implemented whereas the constructs system quality, service quality, and data quality can only obtain "post-IS" data, since the data is about the information system.

Table 16 – Results Case 2	
General	
Function / Role	Controller
ERP system	Baan
Invoice Automation	Readsoft (+ IQBS interface)
Date of implementation	Readsoft: Approx. 1/1/2004
Pre-implement. period "Pre-IS"	1/1/2003 – 31/12/2003 (= 1 year)
Post-implementation period "Post-IS"	1/1/2006 – 31/12/2008 (= 3 years)
System Quality	
Number of times helpdesk support was requested.	Post-IS: 126 times
Number of training hours needed to operate the system.	2 days = 16 hours
Other suggested measures	Daily checking the queues in the process – large queues might indicate possible errors. However, this not registered formally.
Service Quality	
Number of times helpdesk support was requested.	Post-IS: 126 times
Average response time to help requests (i.e. average time that the problem was solved).	24 hours
Number of repetitive problems	Data are not recorded.
Other suggested measures.	None.
Data Quality	
Total number of processed invoices.	Pre-IS: 85.000 Post-IS: 322.000 = 105.000 + 107.000 + 110.000
Number of incorrect invoices, delivered by the vendors.	Data are not recorded.
Other suggested measures.	None.
System Usage	
Total number of processed invoices.	Pre-IS: 85.000 Post-IS: 322.000 = 105.000 + 107.000 + 110.000
Number of invoices processed by the automated invoice system	Pre-IS: 0 Post-IS: 322.000 = 105.000 + 107.000 + 110.000
Number of IS functions used.	Post-IS: 9 functions → eInvoicing; Scanning; Character Recognition; Validation; Matching (3-way); Matching (contract); Routing & Approval; Mobile client(s); Archiving
Other suggested measures.	None.
Performance	
Number of times the invoice is processed incorrectly (e.g. lost documents)?	Data are not recorded.
Number of invoices processed too late?	Data are not recorded.
Number of FTE's needed to process all invoices.	Pre-IS: 3,3 FTE Post-IS: 2,3 FTE
Other suggested measures.	Pre-IS: Data are not recorded Post-IS: 65%

5.2.3 Preliminary Conclusion

This case shows a very good example of how data is only considered important to record if it was used as main selling points in the business case. In this case 'matching-percentages' – the proportion of invoices that met the 3-way matching criteria – were considered as the important performance measures. This is considered as an antecedent of the number of FTE's needed since no human intervention is needed anymore when a invoice match has 'past the test', and hence time reductions are evident. Especially when considering that the amount of tasks increased from 2006 to 2008.

In other words, the main point this case is trying to make is: because the system was implemented and used 100% (no alternative invoice flows are possible), the matching percentages have increased from 2006 to 2009 and while the number of invoices have increased, still there are less FTE's needed to perform all invoices.

According to the organization's representatives, this is satisfying and justifying the business case of the information system, even though the reduction of FTE's from 3,2 to 2,2 is not investigated deeper than that.

5.3 Results Case 3 – The Shared Service Centre

This case observes a multinational organization which is market leader in medical technology. The automated invoice processing system is implemented at a shared service centre, which serves several distant locations. The organization processes approximately 178.000 invoices annually, for which 10.8 FTE's are reserved.

Their most important arguments supporting the business case for implementing an automated invoice processing system were to realize cost reductions and to increase control over the multiple entities (i.e. collect and process all invoices centrally). Besides this, the organization switched to another ERP system in the year of the automated invoice processing implementation.

5.3.1 Interview Description

The interview took place on the 27th of May 2009, with the Finance Process Improvement Manager PtP (Procure to Pay) and the Sr. Finance Manager FSST (Financial Service & Support Team) of the organization. The interview was recorded by using a voice recorder.

The data gathering approach was determined as follows: during the interview the list of items was assessed on quality and understanding. If it was clear what was exactly meant by an item as well as the purpose of it, the data was send by email within two weeks after the interview. That is, when the data was recorded by the organization, else it is marked as 'data are not recorded'. Most of the qualitative data (ERP system, dates, and other methods that were used) were collected during the interview.

5.3.2 Obtained Data

Regarding the number of processed invoices: the only reason for an increased volume of processed invoices – before and after the IS implementation – would be that the number of entities has increased, for which the shared service centre performs the tasks.

Approximately 99% usage means a 'by-pass' or alternative flow of 1% to process the invoices into the ERP system. This by-pass is only the case during emergencies (e.g. system failure or down) and therefore a rather low percentage. In less urgent cases the employees will wait for the system to be up again and do not make use of the by-pass possibility.

The table below is a summary of the data derived from the interview and the follow-up email. The constructs system usage and performance could hypothetically result in "pre-IS" and "post-IS" data whereas the constructs system quality, service quality, and data quality can only result in "post-IS" data, since the data is about the information system. However, in this case the organization does not have the data available about 'period 1' (mainly due to the fact this is more than 5 years ago).

Table 17 – Results Case 3	
General	
Function / Role	Finance Process Improvements Manager PtP Sr Finance Manager FSST
ERP system	JD Edwards is substituted by SAP
Invoice Automation	BasWare IP
Date of implementation	BasWare IP: Approx. 1/8/2005 SAP: Approx. 1/9/2005
Pre-implementation period "Pre-IS"	Not relevant since there is no data available from the JDE period.
Post-implementation period "Post-IS"	From 1/8/2005 to approximately 01/6/2009
System Quality	
Number of times helpdesk support was requested.	BasWare IP tickets since 'go-live': 110 (however, during 'hyper care' period, there was a consultant onsite and no issues were logged).
Number of training hours needed to operate the system.	1/2 day = 4 hours to operate the system primary, after a few months the employee is more efficient
Other suggested measures	System downtime (from Jan09 to May09) = 15 hrs.
Service Quality	
Number of times helpdesk support was requested.	BasWare IP tickets since 'go-live': 110 (however, during 'hyper care' period, there was a consultant onsite and no issues were logged).
Average response time to help requests (i.e. average time that the problem was solved).	High priority: 3 hrs. Low priority: 1 day – 4 weeks (indicative) A distinction is made between high and low priority: high priority means that the system is down: no invoices can be processed. Improvement suggestions for example have low priority.
Number of repetitive problems	Approximately 10%
Other suggested measures.	Logs, plans of action, prioritizing issues and constantly improving. Also in-house data gathering (subjective)

<table>
<tr><th colspan="2">Table 17 (continued) – Results Case 3</th></tr>
<tr><th>Data Quality</th><th></th></tr>
<tr><td>Total number of processed invoices.</td><td>From go live until 10/06/09 (59 entities) total invoice volume = 656.165
Annual number of invoices per country:
<table>
<tr><th>Ctry</th><th>TOTAL</th></tr>
<tr><td>Switzerland</td><td>32,459</td></tr>
<tr><td>Netherlands</td><td>24,735</td></tr>
<tr><td>Ireland</td><td>24,282</td></tr>
<tr><td>Germany</td><td>20,984</td></tr>
<tr><td>France</td><td>14,394</td></tr>
<tr><td>Spain</td><td>9,097</td></tr>
<tr><td>Italy</td><td>8,920</td></tr>
<tr><td>Belgium</td><td>6,660</td></tr>
<tr><td>UK</td><td>5,626</td></tr>
<tr><td>Austria</td><td>4,808</td></tr>
<tr><td>Poland</td><td>3,352</td></tr>
<tr><td>Denmark</td><td>3,215</td></tr>
<tr><td>Sweden</td><td>3,113</td></tr>
<tr><td>Czech</td><td>2,881</td></tr>
<tr><td>Portugal</td><td>2,480</td></tr>
<tr><td>South Africa</td><td>2,410</td></tr>
<tr><td>Hungary</td><td>2,222</td></tr>
<tr><td>Greece</td><td>2,073</td></tr>
<tr><td>Finland</td><td>1,945</td></tr>
<tr><td>Norway</td><td>1,445</td></tr>
<tr><td>Israel</td><td>-</td></tr>
</table>
Current number of entities = 48 (21 countries)
Total = 177.101 invoices over 21 countries</td></tr>
<tr><td>Number of incorrect invoices, delivered by the vendors.</td><td>As a pilot, for one of the entities a zero tolerance process is in place since May08. Number of rejected invoices until May09 = 1170 on total yearly volume of 12,633.</td></tr>
<tr><td>Other suggested measures.</td><td>Data quality also depends on the employee who might enhance the invoice.</td></tr>
<tr><th>System Usage</th><th></th></tr>
<tr><td>Total number of processed invoices.</td><td>Pre-IS: N/A
Post-IS: From go live until 10/06/09 (59 entities) total invoice volume = 656.165
Current number of entities = 48 (21 countries)
Average number of 178.000 invoices per year</td></tr>
<tr><td>Number of invoices processed by the automated invoice processing system.</td><td>Pre-IS: 0
Post-IS: Approximately 1% bypassed BasWare IP due to down time (1% = 6.500 invoices). These invoices were processed directly into the ERP system.</td></tr>
<tr><td>Number of IS functions used.</td><td>Post-IS: 9 functions → eInvoicing; Scanning; Optical Character Recognition; Validation; Order Matching (2 & 3-way); Contract Matching; Approval routing; Mobile client(s); Archiving</td></tr>
<tr><th>Performance</th><th></th></tr>
<tr><td>Number of times the invoice is processed incorrectly (e.g. lost documents)?</td><td>Pre-IS: N/A
Post-IS: Approximately less than 100</td></tr>
<tr><td>Number of invoices processed too late?</td><td>Pre-IS: N/A
Post-IS: Approximately 32% due to invoice receipt in local countries.</td></tr>
<tr><td>Number of FTE's needed to process all invoices.</td><td>Pre-IS: N/A
Post-IS: 10,8 FTE (vendor master & system administrator activities are excluded)</td></tr>
<tr><td>Other suggested measures.</td><td>First time right percentage: approximately 65%
Optical Character Recognition (OCR) rate: approx. 20%
Duplicate processed invoices: approx. 0,96%
Automatically processed invoices (eInvoicing): <5%
Matching (PR/PO) compliance rate = 40%</td></tr>
</table>

5.3.3 Preliminary Conclusion

The organization made clear they would have expected to distribute questionnaires among their employees as well. They thought it would be a valuable addition to include the subjective perspective of the users as well, especially to corroborate with the objective numbers (e.g. derived from the ERP system).

They also suggested looking at line-items instead of invoices to measure usage because invoices can be consolidated.

An important limitation might be that no data were available about ‘period 1’ and therefore no longitudinal conclusions can be drawn for this case.

5.4 Summary of Case Results and Evaluation of Hypotheses

Table 11 below displays the quantitative summary of the obtained data from the three cases, in order to evaluate the research hypotheses in the next paragraph.

Table 18 – Summary of Case Results

Summa-tive Unit	Construct	Measure	Period	Case		
				1[1]	2[2]	3[3]
System Quality[4]	Helpdesk support	Number of times helpdesk support was requested Total number of processed invoices	Post-IS	4%	0,039%	0,00017%
	Ease of learning	Average number of training hours needed to operate the system	Post-IS	16 hrs.	16 hrs.	4 hrs.
Service Quality	Helpdesk response	Average helpdesk response time (per request)	Post-IS	N/A	24 hrs.	3 hrs.
	Problem repetitive-ness	Number of repetitive problems Number of times helpdesk support was requested	Post-IS	25%	N/A	10%
Data Quality	Data Accuracy	Number of incorrect invoices delivered by vendor Total number of processed invoices	Post-IS	6%	N/A	9%
System Usage	Extent of Use	Number of invoices processed with IS Total number of processed invoices	Pre-IS Post-IS	0% 99,6%	0% 100%	0% 99%
		Number of IS functions used	Pre-IS Post-IS	0 7	0 9	0 9
Perfor-mance	Task automation	Number of inv. processed automatically without errors Total number of processed inv. (automatic + manual)	Post-IS	N/A	65%	40%
	Task timeliness	Number of invoices processed too late	Post-IS Pre-IS	N/A	N/A	32%
	Producti-vity	Total number of processed invoices (annually) Number of FTE's assigned to process the invoices	Pre-IS Post-IS	2.500 3.077	25.758 46.667	N/A 16.481

[1] For the 1st case, the pre-implementation period is 2008 and the post-implementation is 2009-Q1.

[2] For the 2nd case, the pre-implementation period is 2003 and the post-implementation is 2006 to 2008.

[3] For the 3rd case, the pre-implementation period is 2004 and the post-implementation is 2005 to 2008.

[4] In the third case, additional data was recorded: the system downtime was 3 hours.

The table below summarizes which relationships are confirmed and which relationships are not confirmed, based on table 18 from the previous paragraph. Three scenarios are possible:

1. The hypothesized direction is confirmed;
2. The hypothesized direction is rejected (i.e. the data suggests the opposite direction);
3. The hypothesized direction is nor confirmed nor rejected (this might be due to the unavailability of data).

Table 19 – Summary of Hypotheses' Findings

Hypoth. Number	Dependent Variable	Independent Variable	Moderator	Explanation / Conclusion
H1	Helpdesk Support Requests	System Usage	None	The direction is confirmed: less helpdesk requests lead to the use of more IS functions.
H2	Ease of Learning	System Usage	None	The direction is nor confirmed nor rejected.
H3	Helpdesk Response Time	System Usage	None	The direction is nor confirmed nor rejected.
H4	Problem Repetitiveness	System Usage	None	The direction is confirmed: better service quality lead to the use of more IS functions.
H5	Data Accuracy	System Usage	None	The direction is confirmed: more accurate data lead to the use of more IS functions.
H6	System Usage	Task Automation	None	The direction is confirmed: using the IS more lead to more task automation.
H7	System Usage	Task Timeliness	None	The direction is nor confirmed nor rejected.
H8	System Usage	Productivity	None	The direction is confirmed: using the IS more lead to increased productivity.
H9	System Usage	Task Automation	Helpdesk Support Requests; Ease of Learning	Since no formal and sophisticated statistical techniques can be used due to the limitations of the data (from only 3 cases), no conclusions can be formulated with regards to the contributions of each of the hypothesized moderating variales.
H10	System Usage	Task Automation	Helpdesk Response Time; Problem Repetitiveness	
H11	System Usage	Task Automation	Data Accuracy	
H12	System Usage	Task Timeliness	Helpdesk Support Requests; Ease of Learning	
H13	System Usage	Task Timeliness	Helpdesk Response Time; Problem Repetitiveness	
H14	System Usage	Task Timeliness	Data Accuracy	
H15	System Usage	Productivity	Helpdesk Support Requests; Ease of Learning	
H16	System Usage	Productivity	Helpdesk Response Time; Problem Repetitiveness	
H17	System Usage	Productivity	Data Accuracy	

5.5 Conclusion

Building on the most influential theoretical foundations of the IS field (i.e. TAM, ISM, TPC, and UTAUT) a new theory is proposed: the Unified Theory of Information System Succes (UTISS), in which instruments of other reference disciplines such as *System Engineering* and *Management* are integrated.

5.5.1 Case Results

The model is tested empirically in three organizational contexts and results from the first case suggest that (efficiency) improvements due to the IS implementations are not always explicitly visible: some organizations maintain their FTE formations while more tasks can be assigned to the same FTE such that the efficiency improves. Furthermore, it appears that major arguments in the business case (such as quality improvements) are not always measured properly, or measured at all. This should trigger practitioners to choose appropriate measures very carefully. On the other hand – as the second case explicates – it is also important to consider more than only the measures that are relevant to assess the business case.

Another important outcome of the pilot-test is that the chosen information system – invoice automation – might not be the best information system to validate this model since one of the two items used to operationalize the construct system usage is pretty much always 100% (except for emergency cases). In other words, to process invoices there is no other option then to use the system (at least for employees: in emergency cases higher personnel can bypass the system). A second item was therefore added to measure system usage: the number of IS functions used.

Although further research should verify the hypotheses outcomes in a more extensive empirical setting (like a cross-sectional comparison of at least 8 organizations such as the comprehensive study of Devaraj & Kohli (2003)), the following preliminary conclusions are drawn:

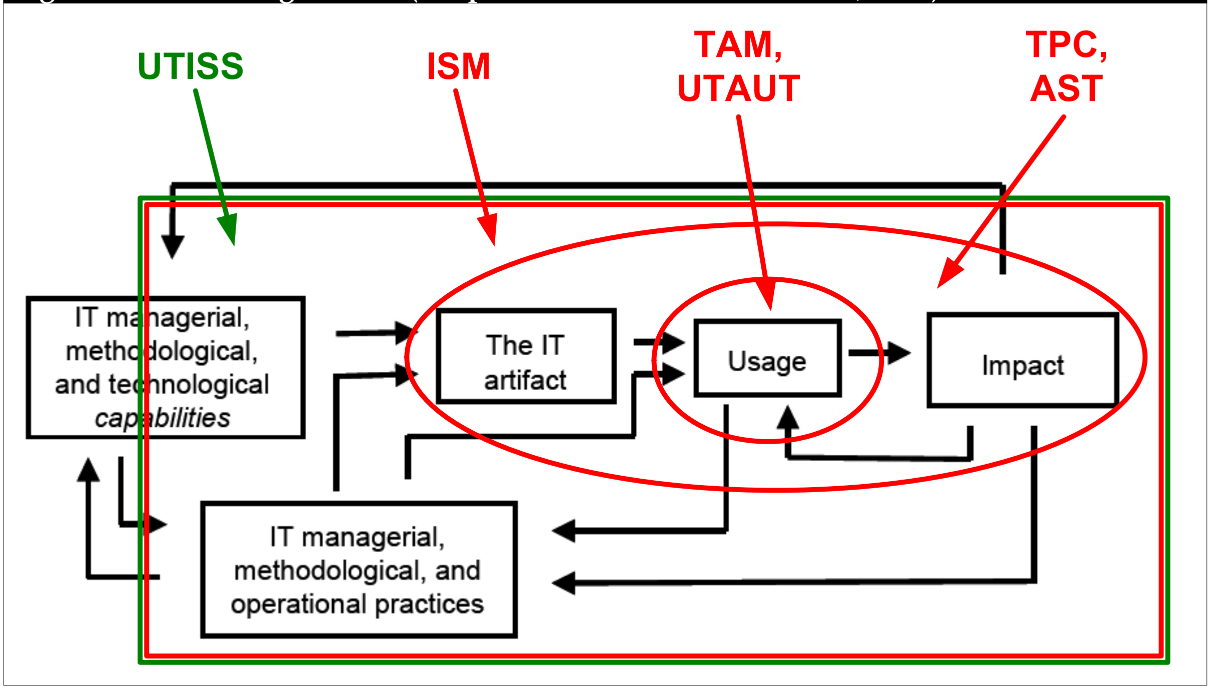
- Less helpdesk requests lead to the use of more IS functions.
- Better service quality lead to the use of more IS functions.
- More accurate data lead to the use of more IS functions.
- Using the IS more lead to more task automation.
- Using the IS more lead to increased productivity.

Although further empirical investigation of UTISS should validate the findings in this thesis, practitioners should welcome the way the model is operationalized and tailored to specific IS contexts. It is therefore proposed to be a useful model for IS practitioners, especially those who would like to investigate current IS implementation projects, say via a ‘post-implementation audit’.

5.5.2 IS Disciplinary Coverage of UTISS

In order to get an overall picture of where or whether UTISS should be positioned in the IS field, the *Nomological Net* of Benbasat & Zmud (2003) is used which defines the boundaries of the IS discipline (cf. figure 19).

Figure 19 – Nomological Net (adopted from Benbasat & Zmud, 2003)



Moody *et al.* (2009) did a similar job in their *search for paradigms*, and they positioned all of the top 5 most influential IS theories (cf. figure 19, the red symbols). Although much better operationalized, UTISS is similar in to DeLone & McLean's ISM in many ways (i.e. constructs, relationships). Therefore UTISS is placed in the Nomological Net accordingly.

5.6 Limitations

The main contribution of this thesis is the assessment and unification of the IS disciplines' foundational theories. Therefore – especially for the empirical part – some limitations have to be made explicit. One important limitation might be that the first case that is examined was still in a 'learning phase' of the implementation project (approximately 3 months), while the other cases where in a more mature phase (respectively 3 and 4 years). Inevitably, this has consequences for the validity of the comparisons.

One of the findings was that invoice processing systems are not the most appropriate information systems to empirical validate the proposed model because usage is – at least at the examined cases – always (nearly) 100%. This means the moment the system was implemented, no other flows of invoice processing is possible than by using the information system. The only difference that can be stated is the number of function used of the information system. More appropriate systems might be for example email and telephone to communicate. This will probably not be a 0% versus 100% division as 40% versus 60% will be more realistic.

5.7 Further Research

As stated earlier, another important limitation is that the UTISS model is tested in only three cases. Although very useful but descriptive conclusions are derived from these cases, it is in no way a formal empirical validation. Future research should triangulate the results by including more cases in the analysis.

5.7.1 UTISS' Nature According to Gregor (2006)

Gregor (2006) proposed a taxonomy that classifies information systems theories with respect to the manner in which four central goals are addressed: analysis, explanation, prediction, and prescription. Accordingly, Gregor (2006) distinguishes between five interrelated types of theory:

1. Theory for analyzing;
2. Theory for explaining;
3. Theory for predicting;
4. Theory for explaining and predicting;
5. Theory for design and action.

Because UTISS main purpose is to explain and predict the impact of information system on organizational performance (or 'business impact', as stated in the title), UTISS is positioned as a 'type 4' theory. Future IS research may elaborate on the theory in such a way that 'evolves' in a 'type 5' theory, that is, a theory for design and action.

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