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MODEL OF BIG DATA FAILURE:

REVIEW OF INFORMATION SYSTEM FAILURE

Master´s Thesis in
Information System Science

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- BD - Big Data
- BDA – Big data analytics
- BIS - Business Intelligence System
- BI - Business Intelligence
- IS - Information System
- MIS - Management Information System
- KMS - Knowledge Management System

1 INTRODUCTION

The purpose of this overview chapter is to introduce the topic of this thesis. First, the phenomenon of big data is discussed and the importance of analytics is drilled into. Second, Business Intelligence is introduced and the relation with big data is outlined. Then, the motivation and research gaps in this topic are discovered and explained.

1.1 Research background

We generate an astronomical amount of data by living our daily lives, around 2.5 quintillion bytes to be more accurate[1]. This is the data that we generate by living our routine daily lives carrying out common activities such as using social media services, making phone calls, shopping or driving to work. Yet, new sources that generate data appear every day, from mobile devices, industry sensors and now, wearable devices lead by the birth the Internet of Things. In fact, it is estimated that 90% of the world's data has been generated in the past two years (IDC 2012).

Large organizations have spent billions of dollars in trying and tap into the potential business benefits locked within the generated data. However, due to its rapid growing nature, more recently smaller companies have been investing in big data technologies in order to find business benefits. According to IDG Enterprise, the number of companies willing to invest in big data analytics grew 5% in the past year[2]. In the United Kingdom alone, SAS forecasts that by 2017, 29% of small and medium size companies[3] will have implemented big data analytics into their business model to expand the capabilities of current Business Intelligence Systems (BIS).

Currently, the worldwide Business Intelligence (BI) market revenue is valued at around $14billion and expected to grow to $17bn in 2015. According to IDC (2012) the majority market segment is services (41.5%), followed by software (30%) and servers, storage and networking (30%). Whereas Statista.com (2015) estimates that the global big data revenue is estimated to grow from $38billion to nearly $50 billion in 2017 distributed between professional services (35%), applications and analytics (15%), computation (15%), and storage (14%), and Cloud and other infrastructure (21%).

There are many challenges in adopting big data of which the most prominent were identified as lack of skills, mainly a major knowledge gap in technical knowledge in development and implementation

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[1]According to the e-book published by IBM 2014 'Understanding Big Data' (http://public.dhe.ibm.com/common/ssi/ecm/en/iml14296usen/IML14296USEN.PDF)

[2] According to IDG Enterprise, carried out a survey with 751 respondents. (http://www.idgenterprise.com/report/big-data-2)

[3] E-Skills and SAS define small and medium size companies as 100+ employees.

of big data systems, lack of user skills[4] and general data privacy issues (Wang, Chu, Tan, Agrawal, Abbadi & Xu 2013; Cumbley & Church. 2013). The knowledge gap between disruptive innovative data solutions and end-user has been a growing trend as pointed out previous Google CEO in an annual technology conference:

"The underlying issue is that people are not ready for the technology revolution for two reasons, one that they do not understand what will happen and secondly the compounding of information and therefore people are not ready for the questions asked by the user powered technology."- Google executive Eric Schmidt (2010)

Previous research shows that there is significant value in IT that translates directly into business benefits (Melville, Kraemer & Gurbaxani 2004). IT is regarded as a supporting component when dealing with the business strategy and is to be used as a tool to develop core competences (Barth 2013). However, executives face one of the most demanding challenges when trying to tap into the strategic potential of IT and transform its benefits for the organization. In fact, technologies develop continuously and business changes even faster, thus keeping up to date with the change remains the greatest challenge for an organization (Lee & Choi 2014). Equally, this is reflected in big data as executives face similar challenges (Jordan 2013). Despite the fact, many companies have shown interest into adapting to the phenomenon of big data with high expectations. However very little research has been done to measure and evaluate if the expectations have been achieved.

1.1.1 What is Big Data?

Identifying the exact origin of the term *big data* has been discussed widely. Multiple timelines describing the history of the term and phenomenon have been discussed (Halevi & Moed 2012, Lohr 2013; Press 2013). One of the earliest occurrences of the term in academia was by NASA scientists Cox and Ellsworth in a paper published in 1997. The scientists identified that datasets were expected to scale up to maximum capacity throughout the evolution of the supercomputers that created them. The keynote on the paper identified that handling big data will be challenging. They in fact began the essay with:

"*Visualization provides an interesting challenge for computer systems: data sets are generally quite large, taxing the capacities of main memory, local disk, and even remote disk. We call this the problem of Big Data.*"

Michael Cox & David Ellsworth (1997)

The definition of big data from a business stance is a complicated subject, as it does not simply mean a large amount of data, however rather focuses on the inability to analyse and sort the data with ordinary tools and methods to extract the full economic value that is locked in the stored data. The concept of

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[4] Accenture 2014, Big Data Big Success – suggests that over 95% of projects used external help to implement big data.

big data cannot be simply defined as definitions vary according to its final use (Strenger 2008). According to various definitions by industry leaders big data is a term describing the analysis and storage of large and or complex data sets using an array of methods and technologies (Ward & Baker 2013).

The concept of big data technologies have mainly been developed by companies to accommodate their own needs, therefore resulting in different variations of definitions. For example, industry leaders have defined big data as following:

The IDC: *"A new generation of technologies and architectures designed to extract value economically from very large volumes of a wide variety of data by enabling high-velocity capture, discovery, and/or analysis. " (IDC.com, 2014)*

IBM: *"Big data is being generated by everything around us at all times. Every digital process and social media exchange produces it. Systems, sensors and mobile devices transmit it. Big data is arriving from multiple sources at an alarming velocity, volume and variety. To extract meaningful value from big data, you need optimal processing power, analytics capabilities and skills." (IBM.com, 2015)*

Rolls-Royce: *"Big Data is about much more than the volume of data, which is generated. It's also about the increasingly sophisticated methods of computer analysis, which can be applied to this data – in the hope of drawing out insights which can drive efficiency and progress." (Paul Stein, Rolls-Royce, CSO, 2015)*

Big data is characterized with three dimensions known as the 3Vs: Volume, Variety, and Velocity (Meta Group 2001)[5]. *Volume* refers to the scale of data that is generated; Facebook alone generates 10TB a day and the total estimated to rise to 40 zettabytes by 2020 (Zikopoulos & Eaton 2012). There is an on-going discussion on the threshold that defines the volume of big data, as it is subject to change in accordance to processing power and storage capabilities (Gandomi & Haider 2015).

Variety refers to the various forms of data, i.e. structured, semi-structured and unstructured. Structured data, which amounts to around 5% of existing data[6], can be commonly observed in tabular form such as spreadsheets. Up to 90% of the existing data is unstructured and is mostly user generated content captured and stored by organizations such as social media content; audio, images and videos. Other unstructured data is gathered from internal sources, such as machine generated and various measuring instruments. Therefore unstructured data is mostly unusable for analysis by computers due the lack of logical format (Gandomi & Haider 2015). Semi-structured data can be viewed as structured data that lacks rational organization. It commonly functions as a semantic bridge between the two most commonly in forms of descriptions of data written in XML or JSON[7]. This allows for machines to understand the relation of the raw data however does not contextualize it as information. Semi-structured

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[5] Meta Group is now known as Gartner

[6] According to Cukier 2010 TNW speech - https://www.youtube.com/watch?v=R-bypPCIE9g

[7] eXtensible Markup Language or XML is a tool for carrying information that is used to add descriptions to data (http://www.w3schools.com/xml/default.asp)

JavaScriptObjectNotation or JSON is a self-describing, language dependent data interchange format (http://www.w3schools.com/js/js_json.asp) data can be found enclosed in common items such as email headers (author, recipient, time) or in image metadata in form of location, time, and date.

Velocity refers to the speed that the data is being created and streamed for analysis. Resolving the difficulty of organizing, merging and centralizing of the data in a timely manner is key to achieving the desired competitive advantage. The reaction time required to carry out the process is crucial, especially in security systems such as flight computers, where multiple streams of huge quantities of information is being processed in near real-time (meteorological data, GPS, wind speed, engine sensor data etc.). In a similar way, there are hundreds of millions of smart devices and sensors that continuously stream organizations with valuable real-time data (e.g. location services for advertisements, search and buying patterns, health data etc.).

The industry leaders and academics agreed on the 3Vs as a standard. However, they argued to use additional dimensions in order to characterize Big Data. IBM[8] devised veracity, the relevance and truthfulness of the data, as a fourth dimension. Much of veracity is based on identifying and decrypting the human factor in data (feelings, tones, typos etc.). SAS[9] on the other hand devised variability and complexity as two additional V's. Variability focuses on the inconsistent peaks in data flow, caused by various celebrated events. Complexity tackles the numerous sources data is gathered from and cleans and links them together using various relationship models. Oracle[10] devised value as the 6th V and it distinguishes the variations in value of data from low volume to high volume of data and attempts to identify the usable therefore valuable data.

1.1.2 Big Data Analytics

Organizations use various types of information systems (transaction processing systems, enterprise resource planning, decision support systems etc.) that absorb and generate huge amounts of data from all levels of the organization in order to stay competitive in the ever-growing market. Yet, without the capability of extracting, transforming and loading (ETL) the data efficiently into meaningful information, warehousing this data would be wasteful. Nevertheless, organizations can unlock the value hidden in the streams of big data when applied appropriately to their strategy and decision-making processes, using suitable infrastructure and analytics. Big data processes can be divided into two groups, data management that tackles the ETL processes and analytics that consist of modelling and analysis, and interpretation of the data (Labrinidis & Jagadish 2012; Gandomi & Haider 2015).

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[8] IBM added veracity as their 4th V – (http://www.ibmbigdatahub.com/infographic/four-vs-big-data)

[9] SAS added variety and complexity as additional V's (http://www.sas.com/en_us/insights/big-data/what-is-big-data.html)

[10] Oracle added Value as an additional V- (http://www.oracle.com/us/products/database/big-data-for-enterprise-519135.pdf)

Big data analytics is the process of acquiring, organizing and analysing large data sets in order to discover useful information or intelligence, from patterns, correlations and trends. Gandomi & Haider (2015) identified some key analytics techniques that have facilitated the emergence of big data analytics. Text analysis or text mining is the process of extracting intelligence from text data by the means of text summarization, information extraction, and sentiment analysis, and question answering (e.g. Apple's Siri or Windows' Cortana)[11], and opinion analysis. Secondly, audio analysis or speech analytics is used to extract intelligence from unstructured audio data mainly by the analysis of transcription of spoken language (e.g. call centres, healthcare, security). Further, video analytics is the process of observing, analysing and extracting useful information from video content (e.g. face recognition for security, behavioural analysis for marketing or healthcare purposes).

Social media analytics is the analysis of structured and unstructured data collected from the existing social media platforms. It combines the previously mentioned analytic techniques by gathering user-generated content, such as images,[12] status updates (sentiments) or videos and connects the data with other data items such as location, product and/or people. Main analytic methods are community detection, link detection and social influence analysis. Finally, predictive analysis works as a statistical method to foresee future trends, incidents and events. Where the common characteristics in big data are heterogeneity, noise accumulation, spurious correlations, and incidental endogeneity[13] all underline the necessity for exploring and developing new methods to gain a fuller understanding from predictive models (Fan, Han & Liu, 2014; Gandomi & Haider 2015). This form of analysis is merely an advance from traditional analytics. In fact, Gandomi & Haider (2015) conclude emphasising on creativeness to gain access to the remaining 95% of produced (unstructured) data rather than solely improving the many common traits shared with the practice of BI.

In fact BI can be seen as an overall term for a set of software tools that allows for reporting, analysis and data presentation to be carried out from readily stored data. It is evident how BDA functions as an evolutionary step within the realm of BI and knowledge management, as they all share the same rudimentary purpose of analysing data and information (Lönnqvist & Pirttimäki 2006).

1.1.3 Business Intelligence

Business intelligence has been an interesting topic amongst IS academics and practitioners (Isik, Jones & Sidorova 2014). In 1958 IBM engineer Luhn defined Business Intelligence as "*the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal"* (Luhn, 1958). BI emphasizes 'the business processes that direct to actions and decisions that improve

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[11] Apple Siri - https://www.apple.com/ios/siri/ & Windows Cortana - http://www.windowsphone.com/en-us/how-to/wp8/cortana/meet-cortana

[12] Microsoft launched their new algorithm that can beat Google's current algorithm by 23%.

[13] Fully explained in - Fan, Han & Liu (2014) 'Challenges of big data analysis' *National Science Review* 1(2), pp 293-314

business performance' (Williams & Williams 2007; Chasalow 2009) or 'the processes of collecting, understanding, ordering, and analysis and exploitation of information in business (Chung, Chen & Nunamaker 2005). In a more technical sense, BI is the process of converting raw data into information, by the use of tools, methods and technologies allowing the user to rend the output more useful (Zeng, Li & Duan 2012). As a result, Business Intelligence Systems (BIS) can be considered as an evolution of the traditional Decision Support Systems (DSS) enable organizations to access, interact and analyse data efficiently for further decision making for their own benefit. Such technologies vary from different tools used for ETL to online analytical processing (OLAP) and data warehousing and different visualisation methods. Furthermore, BI can be applied to business-oriented processes such as e-commerce, e-learning, healthcare, e-government and, security (Chen, Chiang & Storey 2012).

BIS are technological innovations that offer analytical and data integration functions to allow users in various organizational levels to gain valuable information for decision-making (Turban, Sharda & Delen 2010; Puklavec, Oliveira & Popovich 2014). Such systems offer quality information in well-designed data warehouses, and function seamlessly with software tools that allow users to access data in a timely manner, effective analysis and display relevant information allowing for well-constructed decisions to be made (Popovich, Hackney, Coelho & Jaklic 2012). The systems aim to supply users with timely and high quality information gained from a range of raw inputs from all levels of the organization (Rubin & Rubin 2013). The decision making process varies from individual, the issue, and the context, meaning that the skills, the circumstance and the decision environment are the factors that can change the quality of the end decision (Rubin & Rubin 2013).

BI on a technical level functions as a multilayer system consisting of IT and other infrastructure, data acquisition, data integration and, data storage and, data organizing and, analytics and, presentation (Glaser & Stone 2008). It is to be noted that even though BI is an excellent tool for facilitating decision-making processes it does not necessarily reflect in achieved decision quality, however it brings uniformity to the decision making process (Rubin & Rubin 2013). Supported by Myers and Knox (2004) who researched that 80% of executives using BI are supported by correct systems.

1.1.4 Logical fit between Business Intelligence and big data

Business intelligence and big data are very much interrelated when looking at the architecture of the systems (See Figure 1). BI systems traditionally acquire structured data from existing storages or silos inside enterprise systems (pay roll, ERP, CRM, email logs…) however big data technologies has enabled for streams of live data (sensors, social media, GPS) to be acquired in semi or unstructured format. Commonly data systems retrieve structured data and sort and store them in relational database management systems (RDBMS) and other data warehouses, making the process slow and inefficient as it prohibiting real-time analysis. Big data technologies, such as Hadoop or spark, have enabled the data systems to process the large quantities of data in near real-time, using a spread peer-to-peer model and advanced ETL tools. However, big data can also draw data from existing enterprise data environments and combine with other streams of data to be used by end-user applications. These applications are commonly used business analytics software that companies can use for decision-making and to produce various reports, graphs and other presentable works. Enterprise information systems also retrieve information produced from data systems for use in applications.

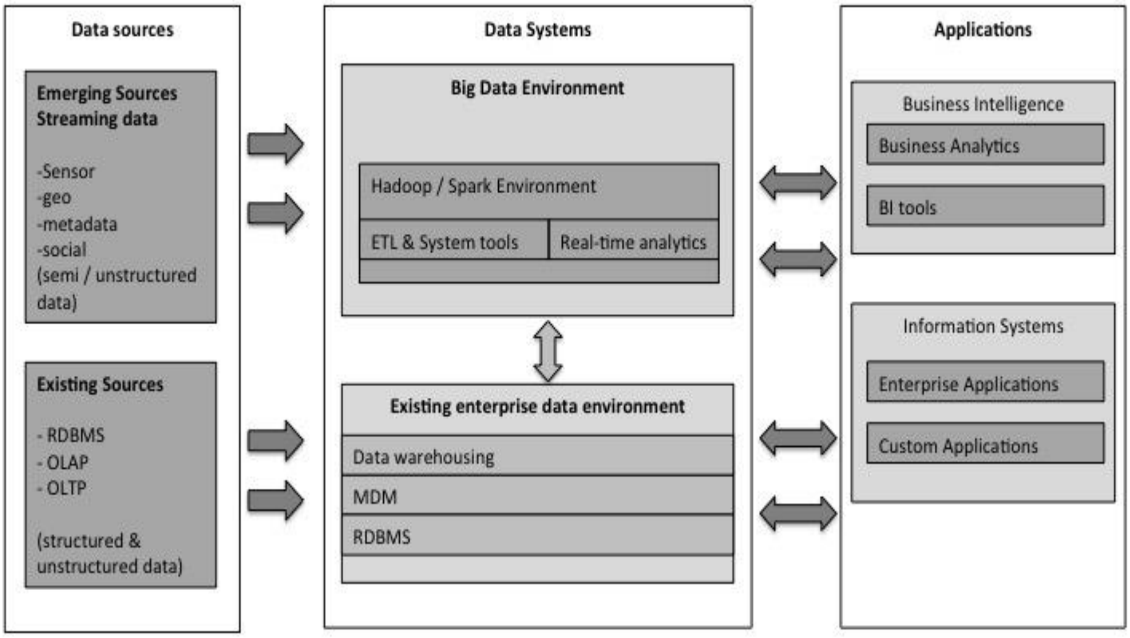

Figure 1 - Business Intelligence and Big Data Architecture

Source: (Adapted from: Hortonworks 2013, SAP 2013)

1.1.5 Why is big data analysis important?

The gains of successful big data analysis can be of enormous business value to an organization. A study carried out by McKinsey in 2011 stated that retailers using big data properly could increase their profits by 60% (Manyika, Chiu, Brown, Bughin, Dobbs, Roxburgh & Byers 2011). This report focused around the value of collecting, filtering and analysing and interpreting the outcome efficiently. Enabling near real-time data analysis is a huge advantage for organizations, from customer profiling to troubleshooting to fraud detection (Manyika et al. 2011). Recently quantitative finance, in terms of High Frequency Trading has leaped from the hands of the big corporations to SMEs that can now afford access to big data. In the high-technology sector, Rolls-Royce has been in the fore front of using big data analytics to gain a fuller understanding of their jet and propulsion products. The company installs hundreds of sensor to different instruments in their jet engines that send a live stream of data via satellite across the globe on engine performance (Stein 2015 from Marr - Forbes.com).

However, as in most technologies, the level of adoption varies, some technologies are easier to adopt than others (such as text analysis vs. video content analysis). This is mainly due to the complexity of the process and hardware requirements. The feasibility of BDA adoption has been facilitated by lower infrastructure costs (Murthy & Bowman 2014). This is mainly due to new competitive new cloud-based services such as Software As A Service (SAAS) and Platform As A Service (PAAS) and Infrastructure As A Service (IAAS) offering Pay as Store or Use pricing models. As many of the fore-mentioned services are offered by large organizations (Microsoft Azure, Amazon Web Services etc.) smaller companies can take advantage of the flexibility. Consequentially, the market has become more competitive and opened space for start-ups to develop innovative solutions using Big Data that can compete with the market leaders.[14]

In addition, BDA technology has gone through a cycle of evolution from its early Apache-Hadoop[15] open-source framework to evolve into an intricate web of supporting frameworks that allow for faster and more complex calculations. Collaboration between UC Berkeley and Databrick has resulted in a new framework called Spark[16], promising performance values 100 times faster and more adaptable and integration friendly to common programming languages. These innovations enable for autonomous machine learning abilities or Artificial Intelligence. AI enables continuous learning from received information, that can be used for generating prediction models and analyse risks that can be used from space exploration to health care (drug optimization, smart health devices etc.) to public safety (cyber security, facial recognition, threat evaluation etc.) to biogenetics. There is even a train of thought that provides a view into the next step of the evolution of knowledge. As information gathering becomes automated, the founding structure of knowledge changes. Eventually, the human aspect of knowledge is eliminated as machines begin to use AI for learning[17].

1.2 Motivation and research gaps

Despite the fact that big data brings a lot of possibilities, it has many challenges and risks associate with big data adoption. Major hindering factors are lack of technical knowledge for implementation, lack of user skills and general data privacy issues (Wang et al. 2013; Cumbley & Church 2013). Such challenges and risks may lead the organization fail to gain benefits from the big data. Thus, further research is needed in order to understand the challenges and risks faced by the organizations.

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[14] According to Forbes (2013) the market leaders in BI & analytics software are: SAP 21%, Oracle 14%, IBM 13%, SAS 12%, Microsoft 9% and others 31%

[15] Apache-Hadoop - http://hadoop.apache.org/#What+Is+Apache+Hadoop%3F

[16] Apace-Spark - https://databricks.com/spark/about

[17] Interview with Professor Luc Steels (http://www.csl.sony.fr/downloads/papers/2003/manuel-03a.pdf)

Prior industry reports as well as academic research focused heavily on the probable gains a business may obtain from the big data. The challenges and risks associated with big data have been overlooked in prior academic research. Putting it in a broader perspective in the IS research, similar conclusion can be drawn. Although IS success research has been a much researched topic (Barki & Huff 1985; DeLone & McLean 1992 & 2003; Chae and Kim 2002; Venkatesh, Morris, Davis & Davis 2003; Sabherwal, Jeyaral & Chowa 2006; Popovich et al. 2014), IS failure has received little attention (Lyytinen & Hirschheim 1988; Cavaye & Christiansen 1996; Wixom & Watson 2001; McManus & Wood-Harper 2003).

While there are extensive studies across success cases of IS, the academic discussion concerning big data failure is still a very fresh topic. Especially, little has been studied about the post-adoption phase of big data use, especially in the executive levels (Jordan 2013). Understanding these will bring light to current challenges users face and can potentially offer learning steps for organizations in the pre-adoption phase.

2 LITERATURE REVIEW

The purpose of this chapter is to provide evidence on the different BIS, KMS and DSS failure and success factors. First, different theoretical frameworks were discussed. Second, the intricate IS literature search process is explained and the various libraries and databases are identified. Then extant literature is reviewed and classed according to its content on IS failure or success cases.

2.1 Theoretical frameworks

2.1.1 DeLone and McLean System Success Model

Information System Success is a complex multi-dimensional and interdependent construct that can be viewed from many different levels; therefore measuring success was a complicated issue until the introduction of the DeLone and McLean's System Success Model (DM SSM). DeLone and McLean (1992) carried out an extensive IS literature review from which they identified a vast amount of success factors and categorized the success variables into a framework (see Figure 2.), which then has become the most extensively cited success model in IS literature (Petter, DeLone & McLean 2013).

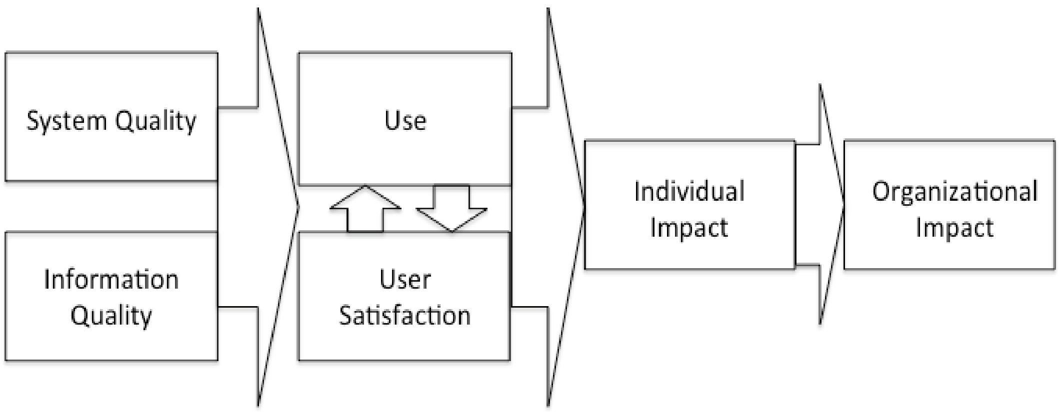

Figure 2 - D&M IS Success Model (1992)

There were six interrelated constructs in the original D&M SSM (1992). It suggested that the success of an IS can be characterised by the system quality, information quality of the output, use of the output, the user satisfaction, the individual impact as the effect of the IS on the user behaviour, and the organizational impact as the effect of the IS on the organizational performance. Using this model the multitude of IS success measures could be classified and the temporal and casual interdependencies with the dimensions could be identified. The model characterises the main factors on system success between information and system attributes representing the information generated and system performance, respectively. The most used attributes focus on system quality, where the overall specifications of the IS are measured and how well it generates information. Then information quality is evaluated on the basis to its desired requirements and ultimately to the use of information by the end user, measured as information use.

After a decade of use and scrutiny in the field, the authors deemed a necessity to assess their model. DeLone and McLean (2003) carried out an intensive literature review from which they proposed an update to the existing model. There were three main updates that distinguished the differences between the original and new model (See figure 3).

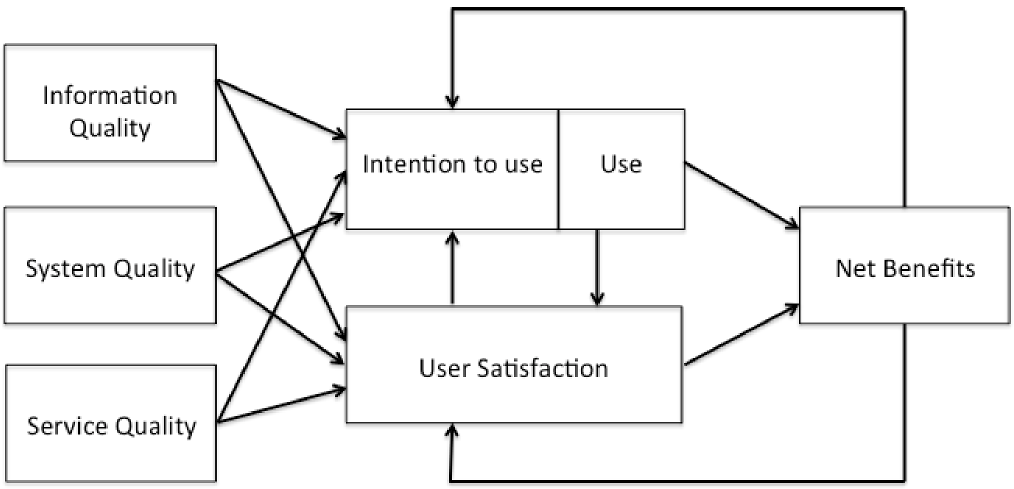

Figure 3 - D&M IS Success Model (2003)

The addition of *'service quality'* as a new measure to the quality dimensions was deemed important to reflect the importance of support and service in IS success. To the behaviour measures user satisfaction and use of the output, *'intention to use'* was added to identify the attitude of the user. The third change integrates the impact dimensions (individual and organizational) into a more parsimonious '*net benefits*' dimensions. Therefore offering a refreshed set of attributes consisting of: information, system and service quality (DeLone & McLean 2003).

Throughout the years, the model has been widely used and validated through various empirical tests that have confirmed the assumption of quality dimensions leading to system use and user satisfaction (Seddon & Kiew 1994; Wixom & Watson 2001; Negash, Ryan & Igarbia 2003; McGill & Hobbs 2003; Wu & Wang 2006Wang & Liao 2008). In order to empirically measure failure a reproduction of the D&M SSM can be drawn, where system quality measures technical success; information quality measures semantic success; and effectiveness success is measured by user and individual and organizational impacts (DeLone & McLean 1992; 2003).

DeLone & McLean (1992; 2003) emphasize that IS success is an interdependent and multidimensional concept rather than a simple process model. Therefore, the net benefits of using a system are derived from an IS and user satisfaction. Where the net benefits reflect the effect of a system at organizational and operational level, and are the most crucial measurements for success as they weigh positive and negative effects (DeLone & McLean 2003).

2.1.2 Technology, Organization, and Environment framework

The Technology-Organization-Environment (TOE) framework was developed by Tornatzky and Fleischer (1990) and is mainly used to structure the adoption of innovation process. The model has been used widely in IS research to analyse different IT adoption cases, such as open systems, (Chau & Tam 1997), websites (Oliveira & Martins 2008), and e-commerce (Liu 2008, Oliveira & Martins 2008; 2009), and Enterprise Planning Systems (Pan & Jang 2008). As a further development Zhu, Kraemer & Xu (2003) developed a conceptual e-business model to measure the factors affecting e-business adoption.

The model divides the adoption of a technological innovation into three contexts, technology, organization and environment (Tornatzky & Fleischer 1990). The *technology context* describes the organizations relevant internal and external technologies identifies together with any existing technologies that the organizations utilizes as well as any other acquirable technologies. The *organizational context* generally defined according to various descriptive measures such as organization size, formal and informal linking structures (level of centralization and formalization), and communication processes (complexity of the managerial structure) as well as the quality of human resources and the amount of available slack internal resources. The *Environment context* explains the surroundings in which the organization operates; the industry characteristics, market structure and, technological support structure that are all commanded by government regulations (See figure 4.)

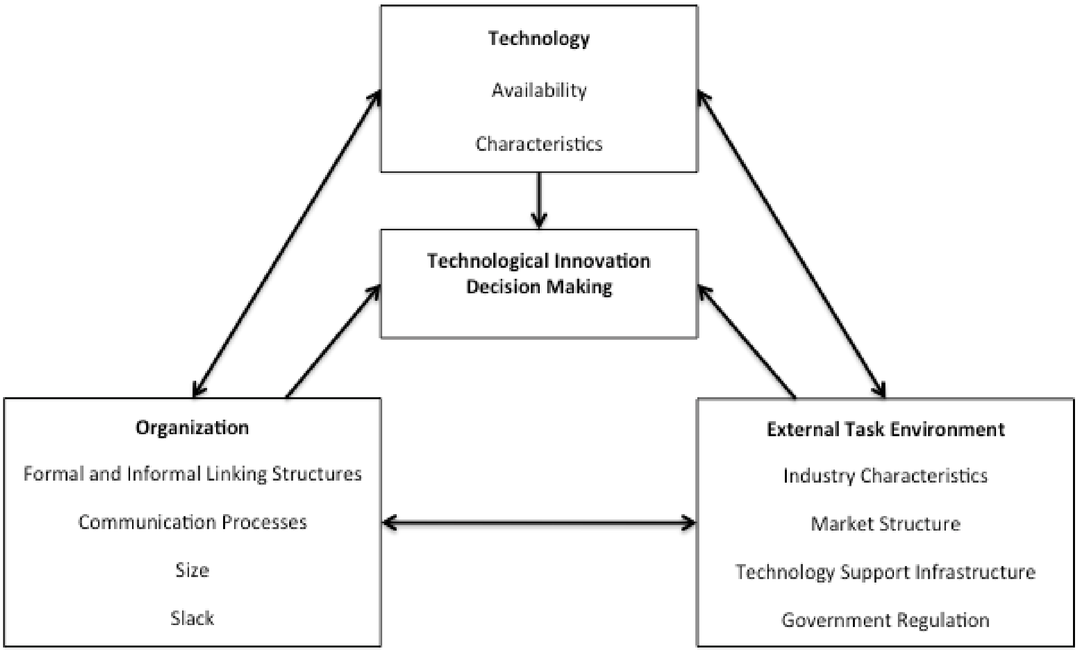

Figure 4 – Technology-Environment-Organization Model

Tornatzky and Fleisher (1990)

As a generic theory of technology adoption, the TOE model can be used to study the adoption of IS innovation, even when an IS has already been adopted by an organization (Zhu et al. 2003). There are three levels of innovation that Swanson (1994) categorized into technical and organizational, and strategic tasks. The type I confines the innovations to technical tasks, Type II are business and administrative support innovations, while Type III are innovations that function inside the core of the business.

Drawing from the categorization, Big Data has developed from being a type I technical task to type II as it is mainly used for executive decision-making and administrative tasks. However, it will develop into the type III as the technology is being integrated into all business areas. Therefore, having theoretically evaluated the different contexts, it is evident that the model can be appropriately used to develop a concept model to study the process of innovation adoption expectations.

2.2 Research Methodology

2.2.1 *Literature search process*

A review of extant literature was carried out among journals and distinguished conference papers. Initially journal databases such as ABI/Inform (ProQuest), Business Source Complete, ScienceDirect, and Wiley InterScience were used to aid the identification process of relevant articles. These databases were searched by using specific keywords such as "Business Intelligence AND Failure OR Success", "Knowledge Management AND Failure OR Success" "Big data AND failure OR success". As suggested by Webster & Watson (2002) a set of journal's table of contents was scanned. The set of journals selected included the top-tier journals ranked by senior scholars: MIS Quarterly, Information Systems Research, Information System Journal, and Journal of the Association of Information Systems, and Journal of Management Information Systems, and European Journal of Information Systems. For the sake of thoroughness, other top-tier journals such as Information & Management, Sloan Management Review, and Decision Sciences were scanned. Distinguished papers such as Harvard Business Review, Communications of the ACM and Proceeding of IEEE conferences were also included.

Subsequently, the author went back by reviewing the citations for the articles identified to find other relevant articles. Each article was read and organized using TOE and D&M SSM framework.

2.3 Literature review on IS failure

Starting with the notion that 'failure' can be used as a root cause to understand success (Oliver 1977) aids the research process to further distinguish failure factors as a surrogate to success factors. The literature is categorized by using of the technology, organization and environment framework (Tornatzky and Fleischer 1990) and DMSS model. This way the author identifies key information, system and other organizational failure issues. Finally, in comparison, IS success literature will similarly be categorized and presented (See appendix A).

This section attempts to clarify the common critical success factors leading to IS failure from a TOE stance by describes the relationships between the various IS failures in the literature review (see Table 1). The term 'failure' implies to '*events that prevent one from achieving the intended use or purpose, when carrying out a task using the specific system'*.

Table 1 - Summary of Extant Literature on General Information System Failures

Authors	Theoretical frame of references	Source of Application	Dimensions + (sub dimensions)	Stage[18]	Methodology	Findings/Propositions
Akhavan & Pezeshkan (2014)	Critical success factor	KMS Failure	**Organizational** [Change management] (lack of motivation for involvement and sharing knowledge, KMS-oriented culture failure, worker resistance) [Project Management] (lack of preparation, lack of knowledge of KMS, Lack of knowledge about organization) [Top level management] (weak conflict management)	D/U	• Grounded theory method by using a collection of KM case studies • Categorizing critical failure factors in each KM cycle stage	• By using a framework of failure factors, organizations can avoid factors that lead to failure in KM systems in each stage of implementation. • Organizations do not produce detailed reports on failures, due to concerns of image and privacy.
Al-Ahmad et al. 2009	none	IS Failure	**Organizational** [Change management] (culture/structure, conflicting interests) [Project management] (Lack of developer expertise, lack of commitment, unclear scope and objectives, lack of user involvement, lack of user commitment) [Top management issues] (Lack of leadership, lack of executive commitment)	D	Literature review	A taxonomy on the IT project failure root causes divided into subcategories. The size and complexity and multifaceted nature of the project effect negatively the execution.
Alter & Ginzberg 1978	None	MIS failure	**Organizational** [Project management] **(**Lack of experience, Size of project, unclear roles, poor planning, weak business cases, lack of user cooperation, multiple designers and users, lack of specific purpose) [Top management issues] (lack of support, lack of management experience, lack of predictability, cost-effectiveness issues, poor technical/cost benefit)	I	Structured interviews	A third of the end-users were satisfied and the information produced by the system was available. Therefore if the users are unsatisfied, the system should be deemed as a failure

[18] Stage of Failure is can be viewed from development (D), implementation (I) and/or use (U) perspective.

Alter 2004	None	DSS Failure	**Technological** [Information Quality] (Poor quality, Poor availability, poor presentation) [System Quality] (poor data storage and retrieval, models, statistical/graphical capabilities, computer interaction, inefficient usage of infrastructure) **Organizational** [Change management] (Lack of organizational participants, lack of training) [Project management] (poor skills, lack of commitment, poor real time feedback, lack of customer involvement in decision process, lack of clear needs) [Top level management] (lack of operational strategy for DSS) **Environment** [External pressure] (poor methods for including problems from surrounding environment)	U	Comparison between two loan systems	Multiple failure elements
Au et al. 2008	Needs theory, equity theory, end-user satisfaction	IS failure	**Technological** [Systems quality] (lack of sound IS) **Organizational** [Change management] (poor support service to end-user, user resistance)	U	922 surveys from hotel and airline sectors	Different users have varying needs from the IS, therefore the satisfaction (success/failure) is hard to measure.
Berthold et al. 2010	None	BI Implementation issues	**Technology** [Information quality] (unease of use, untimeliness, inefficient) [System Quality] (systems designed to accommodate general needs) **Organizational** [Project Management] (Lack of business context, weak business goals, lack of best practices, Long implementation time, poor general design, Lacking focus of user needs) [Top level management] (Poor alignment between business and IT department, unclear business Strategy)	D/ U		BI solutions are designed for enterprise operations and therefore lack options/customisation to sort the needs of different users. This leads to potentially useful data being discarded as the designed system cannot include it.
Beynon-Davies 1995	None	IS Failure	**Technological** [Systems quality] (complex network of various IS) **Environmental** [External pressure] (political and economic context of organization, complex relationship network between autonomous groups) [Service provider] (lack of experience, poor performance [Trust/Privacy] (sensitive healthcare data, no single governance for data and IS)	D	Comparative study of extant literature and London ambulance service computer-aided despatch system IS case study	Multiple failure elements

Biehl 2007	CSF	GIS project	**Technological** [Information quality] (data inaccuracy) **Organizational** [Change management] (poor change management, lack of training] [Project Management] (unclear & undefined goals, poor IS staff capability, poor user attitude, lack of cross functional teams & communication) [Top level management] (Lack of support, Lack of financial resources, unrealistic expectations)	I	Study on 16 implementation projects	Due to the complex nature of project development, proper planning and implementation is vital. As global IS are geographically located in different places, entrusting the project just to HQ is inadequate.
Butler et al. (2007)	Critical success factor	KMS Failure	**Technological** [Information Quality] (Inaccurate, inappropriate results) [System quality] (unease of use, inadequate KMS web technologies, security issues with openness, IT participation and involvement, lack of user participation and involvement) **Organizational** [Change management] (Developing team-oriented culture, lack of trust, lack of training) [Project management] (Lack of definition and communication, lack of knowledge taxonomy, lack of diversity in teams] [Top Level management] (Lack of km strategy alignment with corporate strategy, lack of commitment, Lack of monetary incentives/rewards, changing organizational structures/processes)	D/U	CSF Method	Meaningful to identify between KMS failure/abandonment and IS project abandonment
Cavaye & Christiansen 1996	Self-devised framework	IS implementation	**Organizational** [Project management] (Change in success criteria, change of project scope) [Top level management] (Change in organizational structure) **Environmental** [Trust] (fear of sharing with consultants)	D/I	49 interviews	Changes in subunit power distribution can have a significant effect on the IS implementation process.
Cecez-Kecmanovic et al. 2014	Action-Network Theory	E-business	**Technological** [system quality] (poor performance, lack of functionality according to specifications, poor service) **Organizational** [Change management] (Lack of culture, lack of training, Lack of user participation) [Project management] (poor leadership, lack of business and project planning, unclear project goals, undefined IT artefacts, lack of professional IT expertise) [Top level management] (lack of commitment, lack of support)	U	Case study on an insurance company	Failure or success is determined by socio-material practices, therefore vary from according to users

Chou & Han 2014	None	Business Intelligence Failure	**Technological** [System Quality] (Lack of advanced IT, unsupportive organisational infrastructure, ineffective use of analytical results from the system) **Organizational** [Top level management] (BI-based decision making - Senior management not exclusive as organization wide expertise required, Scenario analysis, individual transaction based profit maximisation, well-structured and clearly defined business performance benchmarks)	U	Comparative study of IS using Guanxi-based decision making philosophy	• Academics are mostly based on western studies •As most software programs are designed for the western market, Chinese companies have difficulties adopting them • Falsified project expectations
Davenport, De Long & Beers 1998	None	KMS Failure	**Technological** [System Quality] (inadequate technical and organizational infrastructure) **Organizational** [Change management] (Knowledge-unfriendly culture, Lacking a link to economic performance and value, Various knowledge transfer channels, Change in motivational practices) [Top level management] (lack of senior management support, lack of funding and resources, unclear purpose and language, Lack of commitment)	I/U	Study of 31 KM projects in 24 companies	Knowledge is a fundamental part of the power in organizations and therefore KM projects vary from traditional IS projects, yet fully dependent on good management
De Voe & Neal 2005	None	BI Failure	**Technological** [Information Quality] (Inadequate Data [Untimely, poor quality, loss of credibility in system) (Unclear results - Lack capability to showing cause/effect, untimely results) [System Quality] (BI Tools problems - Too complex for executives, lack of trust, lack of relevance) **Organizational** [Change Management] (Lack of user skills - lack of end-user training) (Cultural Resistance - [Limited organizational penetration, Fear of change, High cost of distributed systems, concerns over adoption and usability, limited data access to executive data)	U	Study of industry reports	• Standardization of specific tools will enable the organizations to reduce the complexity of BI tools and their implementation • Cultural resistance will face once BI becomes standard practice and executives are proven its strategic value. • Managers are required to respond rapidly and do not always have time to investigate BI tools for answers.
Deng & Chi 2013	Social network theory	System use problems	**Technological** [Information Quality] (reporting issues, data workflow issues) **Organizational** [Change management] (Role authorization, lack of knowledge by user, user-system integration mismatch)	U	Nine month study on user reported problems in business intelligence.	Systems are to be used effectively and efficiently.

Doll & Torkza-deh 1998	E-U sat-isfaction	IS Failure	**Technological** [Information Quality] (Content, inac-curacy, poor format, poor ease of use, untimeliness)	U	Survey of 618 end-users	Multiple failure elements
Doll 1985	None	MIS devel-opment	**Technological** [System Quality] (Inadaptability) **Organizational** [Project Management] (Failure to de-velop project plan, Failure to cover all functional areas, Failure to clarify) [Top Level Management] (Lack of Active executive participation, Fail-ure to plan corporate strategy and policy, lack of adequate decision making, Failure to guide)	D	Field study in 33 or-ganizations	Even though prob-lems during the IS design and imple-mentation phase arise all around the organization it is the Top Manage-ment role to be in-volved and prevent and solve the is-sues. Management and executive issues are significantly more prominent than technical problems
Ewusi-Mensah & Przasnys ki 1991	None	IS project Failure	**Technological** [System quality] (Inadequate technol-ogy) **Organizational** [Project management] (Scheduling is-sues) [Top level management] (lack of MIS manager involvement, Budgeting is-sues, internal politics) **Environmental** [External pressure] (change in organ-izational structure, political)	D/ U	Explora-tory study of 566 sur-vey sent out 49 were usa-ble	Project abandon-ment - it takes place when a com-pany decides to discontinue the de-velopment or use of an information system. These were categorized into two sections depending on their state: project aban-donment if in de-velopment process or system aban-donment if use is discontinued. All abandonments are then measured ac-cording their de-gree: Total, sub-stantial or partial Cost
Ewusi-Mensah 1997	CSF	IS project Failure	**Technological** [System Quality] (Poor technological infrastructure) **Organizational** [Change management] (Lack of Or-ganizational collaboration between stakeholders) [Project Management] (Unclear/un-defined project goals, dysfunctional project team, poor project manage-ment and control, lack of IT know-how) [Top level management] (Lack of in-volvement, Escalating project costs and completion date)	D	Study on airline and hospitality IS	IS projects are per-formed in teams; therefore it is vital for members to communicate, co-ordinate and act as a dynamic group on.

Garrido-Moreno et al. 2014	Self-developed research model	CRM	**Technological** [System Quality] (weak technology portfolio, poor infrastructure, lack of IS integration) **Organizational** [Change management] (Poor training programs, lack of user training) [Project Management] (Lack of employee performance measurements, Lack of rewards based on employee effectiveness) [Top level management] (unacknowledged IS as top-priority, Lack of senior managers motivation and encouragement to build IS vision)	U	International sample of 125 hotels	Organizational commitment and knowledge management is key to translating value from infrastructure.
Gelderman 1998	User Satisfaction	IS	**Technological** [Information Quality] (Content, inaccuracy, format, untimeliness) [System Quality] (unease of Use)	U	Questionnaire to 1024 Dutch Managers, IM Managers	Studies that investigate organizational IS effectiveness should not rely only on user information satisfaction based measures
Gorla Summers 2014	EDT, Agency theory, transaction cost economics	Outsourcing IS project Failure	**Technological** [Information Quality] (irrelevant content, inaccuracy, insufficient information, poor output format, lack of clarity, [System Quality] (user-unfriendliness, unease of use, untimeliness, system not up-to-date) **Environmental** [Service providers] [Poor service quality, Lack of vendor commitment, ineffectiveness of vendor, deliveries delayed, slow implementation]	U	Nation-wide survey using Directory of Top Executives	Switch vendors/ back source as outsourcing has a negative effect towards service quality and perceived usefulness
Hong & Kim 2002	CSF	ERP	**Organizational** [Change Management] (Data misfit, process misfit, user misfit)	D	Survey of 34 organizations	ERP failure rate is dependent to the organizational fit and is measured by the deviation of target cost, time and system performance.
Ives et al. 1983	None	IS Quality	**Technological** [Information Quality] (untimeliness) [System Quality] (Poor decision making performance, perceived quality, System non-acceptance) **Organizational** [Change management] (Use or change In attitudes or behaviour)	I/U	Measuring user satisfaction	Multiple failure elements

Jiang & Klein 1999	None	Project Risks	**Technological** [System Quality] (application complexity) **Organizational** [Change Management] (lack of user support, lack of user experience, lack of user training) [Project management] (lack of team's general expertise, lack of team's expertise with the task, lack of team's development expertise, project size, lack of clarity of role definitions) [Top level management] (resource insufficient) **Environmental** [Industry pressure] (technological newness)	U	Survey on 86 IS project managers	Failure is caused by an array of issues throughout the process levels
Lederer & Sethi 1996	CSF	IS project Failure	**Organizational** [Project management] **(**Lack of Staff expertise, unclear goals) [Top level management] (lack of support, lack of resources, Lack of IT knowledge, inadequate budget, lack of IT alignment with business strategy)	D	Survey on 105 SISP experience	Multiple failure elements
Lee et al. 2002	AIMQ Gap Analysis	Information Quality	**Technological** [Information Quality] (Inaccessibility, inappropriate amount, unreliability, incompleteness, not concise representation, inconsistent representation, not free-of-error, interpretability, un objectivity, irrelevancy, bad reputation, untimeliness, lack of understanding) [System Quality] (unease of operation, security)		Questionnaire	Information quality has become a critical worry for organizations and a growing topic in MIS research. This is due to growth in data warehouses and need for direct access to real-time information.
Li et al. 2012	None	SOX	**Technological** [Information Quality] (Inaccuracy, unreliability)	U	Investigation into the use of Sarbanes-Oxley Case	Managers use the information outputs to make decisions, if the system is flawed, the decisions can be flawed as well.
Markus & Keil 1994	None	IS Design	**Organizational** [Top level management] (Lack of alignment in developer interest, lack of reviews of system design & plans, lack of incentives to focus on use by the system specialist, lack of focus on user requirements, lack of user participation strategies)	D	Case study on an expert system for sales department.	IS do not improve organizational performance neither do they create business value; users create the value. If the system does not carry out what the user requests then the problem cannot be solved.

Markus et al. 2000	None	ERP adoption	**Technological** [Information Quality] (Data quality issues, user data entry errors) [System Quality] (IT infrastructure problems, lack of functionality, system integration problems,) **Organizational** [Change Management] (Software modifications) [Project Management] (loosing skilled IT due to project personnel turnover, lack of staffing due to design errors, **Environmental** [Trust] (Problems with product and implementation consultants, feedback issues with suppliers and customers)	I/ U		High quality data and quality reporting are vital for ERP success. Poor data quality affects the end-users trust and willingness to use system.
McGill et al. 2003	DMSSM User satisfaction	Applications	**Technological** [Information Quality] untimeliness, inaccuracy, poor clarity, incompleteness [System Quality] lack of capacity, inadaptability, unreliability, incomprehension, user unfriendliness, unease of use	D		Users perceptions of IS success has a significant role in application development.
McKinney et al. 2002	Self-devised user satisfaction	e-commerce system	**Technological** [Information quality] (Lack of incomprehension, unreliability, usefulness) [System quality] (inaccessibility, ease of use, navigation) (Frequency, time of use)		Survey of undergraduate and graduate students	Multiple failure elements
McManus et al. 2003	None	IS Project Failure	**Organizational** [Change management] (changes in IS development) [Project Management] (Lack of preparation, poor requirement definition, Lack of understanding of requirements lack of methodology/guidelines, Poor business alignment, insufficient time for testing, Frequent changes by users, Overlooked tasks)	D	Review study on 650 projects in the US	• Project performance is predicted by individual capabilities rather than organizational • Continuous feedback to/from shareholders is key for project success • Either successful or a failure, project reviews should be completed as they contain valuable information and insights for future projects.
Montealegre & Keil 2000	None	IS failure	**Organizational** [Project management] (lack of regular project evaluation, poor crisis management, unrealistic targets, unclear feedback) [Top level management] (Changes in top management) **Environmental** [External pressure] (external project unrelated events, poor stakeholder management)	U		Abandonment through escalation can be solved by phasing out the project into problem recognition, re-examination of prior course of action, lessons leanred and exit strategy

Negash, Ryan & Igarbia 2003	DMSSM / End-user Satisfaction	Customer support systems	**Technological** [Information quality] **(**inaccuracy, untimely, not up-to-date) **[**System Quality] (interactivity, inaccessibility)	U	Survey of 726 internet users	IQ, SQ and ServQ lead to user satisfaction
Nelson, Wixom & Todd 2005	ISS	BIS	**Technological** [Information Quality] (Inaccuracy, incompleteness, untimeliness, poor format) [System Quality] (Inaccessibility, unreliability, poor response time, inflexibility, poor integration)		Sample of 465 data warehouse users	Multiple failure elements
Pan, Pan & Newman 2007	Attribution Theory	IS project failure	**Technological** [System Quality] (poor quality software) **Organizational** [Project management] (Frequent non-critical changes in user requirements, poor project manager, Poor IT staff) [Top level management] (Lack of support to project manager)	D	Interviews with companies	• Attribution errors of learning from previous project mistakes is caused by presence of self-appointed mind-sets, general persistence of negative beliefs, memory decay, selective recall of project events, influence of power dynamics within organization. • Deficiency of project post-mortems lead to a failure
Petter, DeLone & McLean 2013	DMSSM	IS implementation	**Technological** [Information quality] (inaccurate, untimely, incomplete, poor usability, not up-to-date) **[**System Quality] (unease of use, unease of learning, inflexibility, poor response time, lack of interactivity, unreliability)	I	Examination of 600 articles	15 new factors that influence success.
Rainer & Watson 1995	none	Executive IS	**Technology** [Information Quality] (untimely, inaccurate, irrelevant, unease of use, accessibility, inconvenience) [System Quality] (inappropriate software and hardware) **Organizational** [Change management] (organizational resistance, lack of training) [Project Management] (inappropriate IS staff, poorly defined requirements, poor user expectations management) [Top Level management] (Lack of executive sponsorship, lack of top level support, lack of resources) **Environmental** [service providers] (over use of consultants)	D/U	Interviews: 18 executives, 18 EIS professionals and, 12 vendors and consultants. 149 usable Questionnaires from organizations	Multiple failure elements

Saarinen 1996	ISS	IS use	**Technology** [Information Quality] (inaccuracy, poor precision, unreliability, incompleteness, irrelevancy, untimeliness, not up-to-date, poor format, unclear) [System Quality] (poor performance, slow response time, user-unfriendliness, unease of use, inflexibility) **Organization** [Change Management] (resistance to change, lack of training, lack of user participation) [Project Management] (poor decision-making, lack of control, ineffectiveness, poor internal communication,) [Top level management] (weak organizational structure)	U	Survey of 200 largest companies and 25 largest banks in Finland	There are no generally acceptable measures to quantitatively and objectively assess ISS. Therefore researchers develop surrogate measures based on empirical evaluation approaches. These measures are then supported by a multi-item questionnaire
Sarkis & Sundrraj 2003	Is Project Failure	ERP	**Organizational** [Change management] (poor methodology) [Project management] (poor rationalising business processes, rationalising issues according to importance, lack of focusing on analytics) [Top level management] **(**Lack of IT business alignment, Lack of Top Management support)	I		The key factors are vital to enable successful IS projects; however, in some cases they become overlooked as limited by time.
Schmidt et al. 2001	CSF	IS project failure	**Technology** [System quality] (lack of flexibility, instability of system) **Organizational** [Change Management] (culture mismatch, purposeful failure, organizational instability, not managing change properly, failure to manage end-user expectations, lack of cooperation, managing multiple relationships,) [Project Management] (Lack of effective project management skills/methodology, lack of control, poor risk management, lack of planning, unclear/ misunderstood scope/objectives, not a concrete case to build on) (unrealistic deadlines, dependent on higher priority project) (lack of personnel skills/knowledge, lack of interpersonal skills, poor team relationship) lack of available skilled personnel, Insufficient/unsuitable staffing, excessive use of consultants, changing scope/objectives, too many organizational units involved, lack of adequate user involvement, lack of experience of user representatives) [Top level management] (lack of executive commitment, lack of client responsibility, Failure to gain user commitment, conflict between departments, failure of mutual project	D	Delphi study in USA, HK & Finland	The authors revised the list of risk factors that can lead to IS project failure and ranked the top 10 accordingly: • Lack of top management commitments to the project • Failure to gain user commitment • Misunderstanding the requirements • Lack of adequate user involvement • Lack of required knowledge/skills in the project personnel • Lack of frozen requirements • Changing scope/objectives • Introduction of new technology • Failure to manage end-user expectations • Conflict between user departments

			plan approval)(Funding - underfunding for development and maintenance, misestimating, overfunding early underfunding later, failure to identify all stakeholders,) **Environmental** [External factors] (multiple vendors, lack of control over consultants)			
Shin 2003	CSF	BIS failure	**Technological** [System Quality] (incompatibility, Technical complexities in data models, system integration issues, enterprise wide integration, poor source system data quality, consistency challenges, Internal politics)	U	Exploratory study	Multiple failure elements
Srinivasan 1985	MIS effectiveness measurements	MIS	**Technology** [Information quality] (irrelevancy, un-usefulness) [System quality] (Flexibility, unease of use, instability)		Study on 29 organisation MIS	Multiple failure elements
Tait & Vessey 1988	Path analysis	IS	**Technology** [System Quality] (System complexity) **Organizational** [User requirements] (Poor User attitudes) [Change management] (Impact of the system on the organisation) [Top Level management] (lack of resources)	D/U	Study of data from 42 systems	Multiple failure elements
Watson 2005	none	BI failure	**Organizational** [Change management] (organizational politics, lack of user involvement) [Top level management] (Poor management support, insufficient funding]	D/U	Survey study about data warehouse failures across 454 organizations	Failure is measured according to its definition: Behind schedule, Weak management support, insufficient funding, inadequate user involvement, organizational politics
Wilson & Howcroft 2002	none	IS	**Technology** [System Quality] (under performs, un-usability) **Organizational** [User requirements] (user dissatisfaction) [Change management] (Impact of the system on the organisation) [Top Level management] (lack of resources)	U	Social studies of technology approach	Failure is a social accomplishment: the technology can remain the same, but the user can change how they perceive it.
Wixom & Todd 2005	User Satisfaction and Technology Acceptance Model	IS Failure	**Technological** [Information quality] (Inaccurate, unreliable, untimely, irrelevant) [System Quality] (unreliability)	U	Model tested on a survey sample of 465 users from seven organizations	Classification of variables and characteristics leading to user satisfaction and TAM

Yeoh & Koronois 2010	CSF	BIS failure	**Technological** [Information Quality] (poor data quality, poor data integrity) [System Quality] (Lack of scalability, lack of flexible framework, poor source system) **Organization** [Change management] (lack of user oriented change management, lack of training, lack of user involvement) [Project Management] (Lack of project champion, poor team selection, lack of project scope and planning, lack of cross-functionality) [Top Level Management] (Lack of commitment, lack of support, lack of sponsorship, Lack of vision, lack of established business case) **Environment** [service providers] (poor usage of external consultants at early phase)	D/U	Delphi method	Data and technical factors were not amongst the top critical factors, as most technical issues can be resolved by technical solutions. The greatest difficulty is achieving commitment in management and organizational level. Support received from the organizational level reflects through the business stakeholders in form of attitudes in change, time, cost, and technology and project scope.

2.4 Understanding IS Failure

Failure as such is rarely a pure technical problem rather an organizational one (Fitzgerald 2004). Markus & Keil (1994) stated that IS failure is only when the total abandonment of the system use has occurred, rather than not meeting user expectations.

Even though big data failure is a growing topic amongst researchers (Jordan 2013), an extant literature review on IS failure indicates to a lack of academic research into this occurrence. From the literature review in existing IS failure literature (See Table 1) the author has identified failure factors that echo throughout, forming a common trend. This trend is evident from the large proportion of articles (See Table 1) that point to critical failure causes to be in the associated with '*developmen*t' and '*use of IS*' failure classes. Lyytinen (1988) proposed four classes of IS failure, that are reflected through the literature review (Table 1). The primary class is the *information system* itself that is formed by the hardware, software, design and documentation related instances. The secondary class is the *information system environment* where individual, organization and environment reasons have effect. The tertiary class involves the *information system development* process, involving design tools and methods together with and organizational and management principles. The fourth and final class similarly involves the *environment of the information systems development* process where users and designers characteristics are valued.

Then again, the D&M SSM also supports that using a classification system of success/failure factors can be used to identify failure. However, as a modification to the model, *service quality* (not a dominant factor to IS success according to reviewed literature) can be substituted to organization quality. Therefore, it makes sense to draw from Tornatzky and Fleischer's (1990) TOE framework the three major failure factors: *technological-, organizational- and environmental.*

Albeit acceptance of an IS can be viewed as the primary step towards achieving IS success, the overall success is dependent on its continued use rather than just primary implementation (Bhattacherjee 2001). This is due to the fact that corporate failures can be caused by the lack of effective, suitable and regular long-term use of IS (Lyytinen et al. 1987; Bhattacherjee 2001).

Even though many studies attempt to differentiate the causes of IS failure by deriving new models and classification systems, such as critical success factor lists, very few are focused on business intelligence or big data. Many of the studies followed exploratory approach and as such failed to offer a valid theoretical stance. Main reasons for this may be a result of adaptations of previous studies that have also lacked theoretical ground in IS failure. In fact most studies consider failure as a *one-dimensional* construct, thus the multi-dimensionality of failure is being overlooked (Doll 1985; Lederer & Sethi 1996; Ewusi-Mensah 1997; Jiang et al. 1999; Watson 2005; Bednar et al. 2011 from Literature Review A). This notion of the multi-dimensionality comes from the core of the existence of IS as it is not just a process or function but an organism composed from multiple tentacles reaching to all stages of its life cycle. This is with exception to studies that have mainly identified critical success factors (Ewusi-Mensah & Przasnyski 1991; Shin 2003, Wixom & Todd 2005; Yeoh & Koronois 2010) that have added dimensions of failure from other dimensions such as information, organization and technology. These studies however lacked further investigation into the post-development issues that reflect the learning from IS failures.

The topic of project post-mortem was investigated by Pan, Pan & Newman (2007) where the attribution errors from previous project downfalls are overlooked due to personal beliefs, self-preservation and organizational politics, causing a reciprocal effect on not learning from failures and passing the errors on to the next project, thus accumulating the expectancy of failure. New IS is introduced to replace old incumbent systems yet, the existing user habits can work against enabling the implementation and disrupts the process on an organizational and individual level (Polites & Karahanna 2013). This is vital in the design process of the IS project where communication and feedback from interacting with customer and end-user has been identified as a leading cause to eventual IS failure and abandonment (Lederer et al. 1996; Schmidt, Lyytinen, Keil & Cule 2001; McManus et al. 2003; Al-Ahmad et al. 2009 from Literature review A).

The number of IS failure studies in the IS field is a much under discussed topic when compared to the topics of IS success. The topic of IS success was already growing however it became very popular after DeLone and McLean's system success models (1993; 2003). It is also argued that failure is not necessarily the opposite of success but can be viewed as a multiway facilitator that enables and logically connects levels between technology-, organization- and environment artefacts that help define the reason behind failure. Viewing failure from a TOE aspect comes from the system success research. Failure is a multilevel structure that is mainly consisted of the system not living up to expectations, rather than total operational failure (Lyytinen 1988; Chou & Han 2014). It appears that costs and time are the main criteria to explain failure (Brooks 1975; Doll 1985; Ewusi-Mensah et al. 1991; Dorsey 2000 in Literature review A). This also supports the common notion that failures are less celebrated than success stories, especially in industry reports and academic papers that study them.

When applying to knowledge management field, Davenport et al. (1998) deemed the terms success and failure as ambiguous, however identified common key characteristics that lead to success. Similarly, BI/BD failure can also bring events that are unique from the ones leading to system success. Previous studies reflect that system success can be used as a predictor for end-user satisfaction (see DeLone & McLean 1993; 2003) and this evident from the literature review carried out as it brings to light the whole new aspect of organizational responses. End-user satisfaction is the emotional assertiveness towards a certain information system or software (cf. Doll & Torkzadeh 1988, 5) by a single or a group of individuals who interact or affected by the information system (Rockart & Flannery 1983; Khalifa & Liu 2004). The most extensively applied instrument for measuring end-user satisfaction was developed by Doll & Torkzadeh (1988) where five key factors were identified: content, accuracy, format, ease of use and timeliness. DeLone & McLean (1992) included the quality of information artefacts generated by the system, as a main factor to be included in measuring IS success.

Throughout the following section Information and System Quality will be viewed as a measure to assess the level of failure (or lack of success). The author draws on the multiple dimensions of quality Reeves & Bednar (1994) identified. The authors identified four separate quality perspectives: quality as excellence, where quality has an absolute standard that can be measured; quality as value where excellence is to be assessed against costs of achieving excellence; quality as conformance with specifications is to measure the consistency of quality with the initial design value; quality as meeting expectations, where the end-users expectations are measured against through excellence, value or other points that shape the customers anticipations of qualities (Reeves & Bednar 1994; Nelson et al. 2005).

3 DEVELOPING RESEARCH FRAMEWORK

The purpose of this findings chapter is to introduce the developed failure model drawn from the literature review carried out in the previous chapter. For further analysis, the categorized contextual elements are tabulated and categorized into first and second order constructs. Then each contextual element is expanded and further defined. The model is then critically viewed by adapting to success literature from the perspective of KMS, BI and big data.

3.1 The proposed framework

A failure model is constructed by adopting characteristics from Tornatzky & Fleisher's (1990) Technology-Organization-Environment model to identify main critical failure factors found in extant literature on IS failures to categorise each factor into their appropriate families. The primary level includes technological aspects from information quality and system quality categories. The secondary level holds failure factors from the organization level, where user requirements, change management, project management and top-level management factors leading to failure are categorized. Lastly, the environment factors that enclose the surrounding situation where the IS operates, the laws that govern the organization and trust and privacy relations between third party suppliers (See figure 5.)

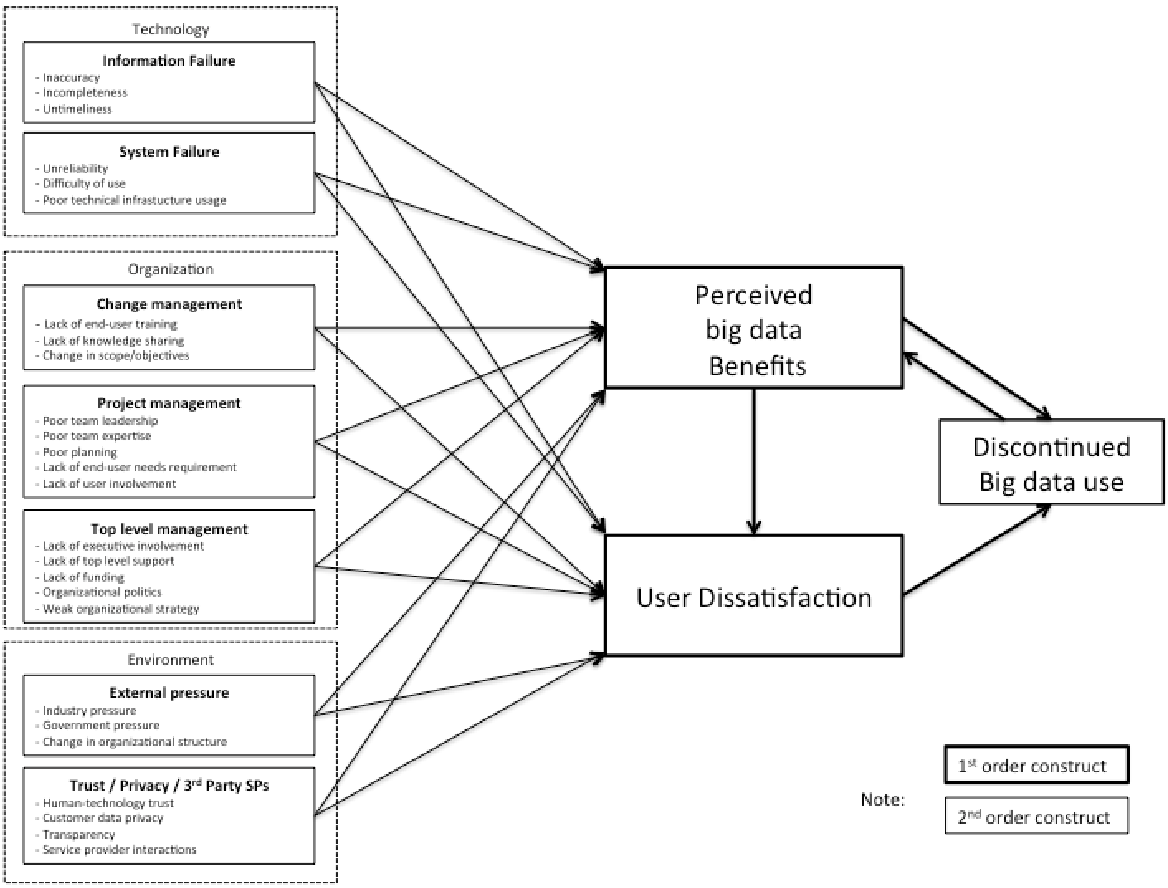

Figure 5 - Failure model

3.2 Filling the semantic gap between IS failure and big data failure

The model was drawn from an extensive study on IS literature and most common failure factors are identified, categorized and further grouped into a IS failure model. The model will then be used to scrutinize extant Business Intelligence, Knowledge Management and Decision Support system literature in order to validate its functionality. The model will then be used to validate the perceived benefits, user dissatisfaction and eventual system use, in terms of big data.

There is an extensive amount of available information about the root causes leading to IS failures (table 1.). There however is an apparent connection on how IS failure cases are relevant to the new innovative IS projects in terms of development, implementation and usage. By applying the developed IS failure model (figure 5.) to the emerging technology of big data, the author aims to bridge the gap between ‘traditional’ and ‘new’ IS projects. Generally speaking, traditional projects are considered as highly centralized IS operations using very rigid and sequential development methods, rather than applying the new ‘value adding’ end-to-end enabled cloud-based solutions developed in iterations using mainly agile methods.

As a motivation the author takes into consideration the fall backs of emerging technologies from an academic perspective. The field of study into big data failures are very much unexplored to especially when comparing to general IS failure research. This thesis will bridge the gap between general IS failure by drawing and identifying the similar key characteristics of that drive business intelligence and big data (identified in chapter 1) initiative to failure.

In order to bridge this semantic gap, big data as is to be viewed as both as a technology as well as a business capability. By granulating big data into its main ‘six V’s’ constructs (See chapter 1.1.1) and applying its expected business capabilities, a logical connection between the technological (information quality and system quality), organizational (project management, change management and top level management) and environment (external pressure, and trust and privacy) can be investigated. The process of identifying the semantic gaps was carried by analysing the data extant IS failure literature and intuitively using a tabular form to categorize key contextual elements. As evident from the research, the main contextual elements identified resonate throughout the IS failure literature (see table 2).

In order to semantically connect the gap in the theory, the author draws together the contextual elements of IS failure and investigates the extant business intelligence and big data literature (see appendix A). Referencing to the TOE methodology the success literature is similarly tabulated showing the semantic relationship between failure and success. The similarity of the leading failure causes and how they can be reversed to reflect success is surprising.

Table 2 - Contextual elements – IS critical failure factors leading to big data failure

2nd order constructs	1st order constructs / Critical Failure Factors	Contextual elements	Definition	Authors
Technological				
Information Quality	Inaccuracy	- Big Data system produces incorrect information - There are many errors in the information I obtained from Big Data - The information provided by Big Data is inaccurate - The data at source system was low quality - The system provides imprecise information	Degree of freedom from error	Bailey & Pearson 1983, Doll & Torkzadeh 1988, Goodhue & Thompson 1995, Rainer & Watson 1995, Saarinen 1996, Lee et al. 2002, McGill et al. 2003, Negash et al. 2003, Nelson et al. 2005, Yeoh et al. 2008
	Incompleteness	- The big data system provides incomplete information - The big data system does not provide all the information needed The information provided by the system is incomplete	Level of how much data is present	Saarinen 1996,Lee et al. 2002, McGill et al. 2003, Nelson et al. 2005, Gorla & Somers 2014
	Untimeliness	- The big data system does not produce most current data. - Big data system does not provide most recent information. - The information from big data system is never up-to-date - The information needed was not delivered on time	How up-to-date the data is and how fast it is available to the end-user	Ives et al. 1983, Rainer & Watson 1995, Saarinen 1996, Lee et al. 2002, McGill et al. 2003, Nelson et al. 2005, Gorla & Somers 2014
	Irrelevance	- The big data content was not what I expected - The big data produced was not up-to-date - The big data provided was irrelevant - The system's information content did not meet needs - The EIS provided inconvenient information	Appropriateness of data for given use	Bailey & Pearson 1983, Ives et al. 1983, Rainer & Watson 1995, Saarinen 1996, Lee et al. 2002, McGill et al. 2003, Gorla & Somers 2014,
System Quality	Lack of reliability	- The big data system operates unreliably - The big data system is unstable - The big data system produces unreliable output/reports - The big data system uptime is inadequate? - Corrections to the system are hard to make	The level dependability that the system operates- and performs reliably	Rainer & Watson 1995, Saarinen 1996, Lee et al. 2002, Nelson et al. 2005, Gorla & Somers 2014

	Complexity of use	- The big data system is not easy to use - The big data system is not user-friendly - The system required lots of training - The system was hard to use, especially after a long period of non-use - The system is hard to learn by new users - Queries are hard to make	The extent to which the systems is easy to use, understand, and user friendly.	Rainer & Watson 1995, Saarinen 1996, Doll & Torkzadeh 1998, Lee et al 2002, McGill et al. 2003, Rai Lang Welker 2002, Seddon et al 2010, Gorla & Somers 2014
	Poor infrastructure and Integration	- The infrastructure is incapable of handling big data - The existing infrastructure is inflexible/un-scalable/inextensible - The company has inappropriate hardware infrastructure to serve its customers - The system cannot be run on other computers - The system cannot be used in other similar organizational environments, unless major modifications are done	The state of the existing hardware and IS and its ability to communicate effectively with a new IS.	Saarinen 1996, McGill et al. 2003, Nelson et al. 2005, Yeoh et al. 2008, Garrido-Moreno et al. 2014
ORGANIZATIONAL				
Change Management	Lack of end-user training Lack of Knowledge sharing Change in project scope / objectives	- Lack of training and support - Employees at all levels lack commitment in using a new IS to achieve customer satisfaction. - Our employees are not well trained in the use of new technologies - The operation of the system requires lots of training - Knowledge was not shared adequately - Changes in scope / objectives were communicated unclearly	How an organization responds and manages change within.	Rainer & Watson 1995, Lederer & Sethi 1996, Saarinen 1996, Schmidt et al 2001, Watson 2005, Yeoh et al. 2008, Garrido-Moreno et al. 2014
Project Management	Poor team leadership Poor team expertise	- Inadequate Project management skills - Ineffective development methodology - Lack of staff / skilled workers	-How resources (e.g. capital, IT and people) are managed to achieve a collective goal by carrying out a series of tasks.	Rainer & Watson 1995, Saarinen 1996, Jiang & Klein 1999, Schmidt et al. 2001, Watson

	Poor planning Lack of end-user needs requirement Lack of user involvement	- Project scope was unclearly defined - The user requirements were not understood in development phase - The user expectations were managed incorrectly - The user committed inadequately - Lack of user involvement through big data project life cycle	-The level of involvement of the end-user on system success	2005, Yeoh et al. 2008
Top-level Support	Lack of executive involvement / sponsorship Lack of organizational support Lack of funding / resources Organizational politics Weak organizational strategy	- Top level management are uncommitted and lack motivation to support project manager - The company senior managers do not consider new IS as top-priority - Inadequate resources were provided - Poor executive sponsorship - Lack of top-level management support - Poor alignment of big data project with organisational vision	How top-level management (e.g. executives and high level managers) support the projects in their various phases, in terms of commitment, resources and knowledge. How well top-level management has aligned projects with organization strategy and communicated it throughout the organization.	Rainer & Watson 1995, Lederer & Sethi 1996, Saarinen 1996, Schmidt et al. 2001, Watson 2005, Yeoh et al. 2008, Garrido-Moreno et al. 2014
ENVIRONMENTAL				
External Pressure	Industry pressure Government pressure Change in org. structure	- Regulatory compliance affects data quality - Organizational structure is affected by new acquisition - Technological newness		Cavaye & Christiansen 1996
Trust / Privacy / External Service providers	Human-technology trust Customer data privacy Transparency	- The data cannot be shared with consultants - Healthcare data has laws to protect its privacy - Vendor dependencies complicated the project - Use of consultants failed to bring value - The system and services are not continuously improved		Jiang et al. 1999

1st order constructs			
Perceived benefits	- Sales have improved - Profitability has improved - Market share has increased - System is used - Completed system functionality relative to original project scope	- Enabling redesign of business processes to support strategic business objectives.	Markus et al. 2003, Watson et al. 2002, Chen et al. 2012, Garrido-Moreno 2014
User dissatisfaction	- The system failed executives to achieve higher-quality decisions - Planned business results were not achieved	- Dissatisfaction is an emotion that reflects the reaction towards the experience of use of an IS.	Spreng et al. 1996, Bhattacherjee 2001, McKinney 2002, Markus et al 2003, Chen et al. 2012
Big data discontinued use	- The system was discarded - Disuse of data and decision analyses produced by the systems	- A chain of events that lead to abandonment of use of a given system.	Markus et al. 2003, Chen et al. 2012

3.3 Technological Failure

The DM SSM (Seddon 1997, DeLone & McLean 1992; DeLone & McLean 2003) theorised IS success as a tri-level construct: technical, semantic and influence/effectiveness. Here the semantic level and technical levels are discussed that represent information quality and system quality, respectively. Both poor information quality and poor system quality are antecedents to IS failure, since information quality is affected by system quality as information is an output of the system (Nelson, Todd & Wixom 2005). This thesis therefore identifies the main factors from papers that discussed these technological inadequacies and related them as major causes behind IS failure.

3.3.1 Information Failure

Information is created by information systems, and as in general manufacturing raw materials, in this case data, is converted into information (Wang 1998). In manufacturing the quality of the output is a key success factor and so it is in the case of information (Wang 1998; Li, Peters, Richardson & Watson 2012). In IS research, information quality (IQ) can be viewed as perception of the user of a function of the value of the output produced by an information system (Negash et al. 2003). IQ has grown as a topic of study as researchers and companies have identified IQ as a '*critical concern of organizations*' (Lee, Strong, Kahn, & Wang 2001, 132) due to the growing amount of new data warehouses and necessity for high quality information to be used for real-time applications. Throughout Table 1 and as evident from the DM SSM, information quality (IQ) and system quality (SQ) a direct effect on information system failure (DeLone & McLean 1992; DeLone & McLean 2003; Shin 2003; Alter 2004; Wu & Wang 2006; Wixom & Todd 2005; Yeoh & Koronois 2010 from Table 1). Also evident from the extant literature is that there is no agreed list of IQ factors that can be used to measure IS failure as all failure cases differ from one and other (McKinney et al. 2002). It is generally accepted that most common data and information factors affecting failure are: Inaccurate; Unreliable; Untimely; Irrelevant; Unsustainable; Lack of governance; Unavailability (DeLone and McLean 2003; Negash et al. 2003; Nelson et al. 2005; Wixom & Todd 2005; Petter et al. 2013).

Business intelligence systems depend greatly on the quality of information available especially when integrated to other organizational IS such as ERPs. This is due to the fact that the higher the quality of information, the more accurate, reliable, timely, and relevant the outputs are, especially when used for management decision-making (Krishnan, Peters, Padman & Kaplan 2005; Li et al. 2012).

3.3.2 Inaccurate Information

It is commonly accepted within the IS literature that the information accuracy is a key determinant to a successful system (DeLone & McLean 1992, 2003; McKinney et al. 2002; Negash 2003; Wixom & Todd 2005; Hostman 2007; Biehl 2007; Seddon et al. 2010; Petter et al. 2013; Kettleborough 2014). IS researchers have commonly defined accuracy in terms of correctness of storing information so that it represents the real world appropriately (DeLone & McLean 1992, 2003; Klein et al. 1997; Nelson et al. 2005). Measuring accuracy is usually straightforward when the value is known and is comparable to the definite value, however in data, the issue of accuracy grows with its complexity and uncertainty (Redman 2005 in Wang et al. 2005). Drawing from rudimentary business intelligence and big data constructs (i.e. ETL, OLAP) information accuracy can defined as *the level of freedom of errors in data*. Data analysis can be carried out by gathering data from multiple available secondary sources, (census' and other public and private structured databases) it is crucial that the data is accurate as limited resources (e.g. time, manpower and hardware) are available to verify the content and its validity. Thus accuracy is vital for producing valid analyses. Park et al. (2012) highlighted the fact that the deeper the level of inaccuracy of information the less value can be extracted from the BIS. Alter (2004) studied two banking DSS and concluded that a loan approval process is fully reliant on accurate information. Butler et al. (2007) listed accuracy of the end result a critical success factor in KMS implementation success, as the systems value is generated from the capability to represent meaningful and accurate knowledge. Nelson et al. (2005, 215) concluded that accuracy had the greatest effect on IQ in all BI tools. A factor also identified by Jonsson, Harris & Nass (2008) when evaluating the critical aspect of information accuracy from traffic, routes and road conditions to provide real time data to drivers. In some cases regulatory compliance can be affected by poor data quality, which leads the end-users to not trust data in system.

3.3.3 Incomplete Information

In addition to accuracy the completeness of data is a key determinant in system success (see DeLone & McLean 2003). Nelson et al. (2005, p. 203) defined completeness as the level to which all achievable conditions relevant to the end-users are represented in the information held and expressed the subjectivity of completeness relative to the end-user and task. Wixom and Todd (2005) also established that information can only be considered complete when an IS is able to carry out all essential tasks in terms of systems capability to produces a complete set of necessary data. Simplistically, the query is about evaluating if the system produced the information in complete (McGill et al. 2003). All in all the completeness of information is a subjective matter that can only be determined by the end-user, as the same information can be complete to one person yet incomplete to another (Wixom & Todd 2005).

3.3.4 Untimely Information

Timeliness of information is also known as currency (Wixom & Todd 2005; Nelson et al. 2005) as it refers to the current state of the information. It expresses if the data in the system updated constantly enough to guarantee usable information and if the systems are updated fast enough to make it a valuable (Ives et al. 1983; Barki & Huff 1985; Klein et al. 1997; Ballou et al. 1998; Gelderman 1998; Lee et al. 2002) factor, especially important in the case of real-time data streams. In business intelligence research, timeliness is measured by comparing the difference between the instances the data was created and when it is available for use by a given system. In general IS literature it aims to discovery whether the information was delivered to the user in adequate time to carry out the task (McGill et al. 2003). Yet timeliness is an instrumental characteristic of system quality as it is dependent on what the end-user expects and requires from the task (Ballou et al. 1998; Wixom & Todd 2005).

3.4 System Failure

System quality can be considered as the extent an information system can cope with changes in data inputs, data processing and/or outputs (Doll 1985). Sabherwal et al. (2006, p. 1851) defined system quality in terms how reliable, easy to use and what the response time is. While Li et al. (2012) evaluated that the main IT failure measures are data processing integrity, system access, security, system structure and usage. Even though various IS studies point out system failure as a factor in IS failure (See Table 1), it is to note that most of the research was conducted decades ago. The traditional methods of carrying out business have changed and given the new form of operating business using technological advances and innovation (SAAS, PAAS, and IAAS etc.). Due to the decentralization of technology, businesses are less prone to hardware failures (due to redundancy protocols) and able to upgrade the hardware to fit their "*economy*", a term used by McGill, Hobbs & Klobas (2003, p. 41) used to define the capability of the system to increase data processing.

Nevertheless the system failures in IS literature point out that some system quality issues continue to reign: inadaptability; unavailability; unreliable; time of response; usability; Interaction failure; (Seddon 1997, DeLone & McLean 2003, Wixom & Todd 2005, Petter et al. 2013). Poor system quality decreases the accuracy of management forecasts, as discovered when comparing banking information systems (Li et al. 2012). Hannula & Pirttimäki (2003) point out in their research that the most beneficial aspect of using a BIS is the quality of information used for organisational decision-making. They also argue that by improving the system quality the quality of information will be positively affected.

Therefore, this thesis continues to draw from extant literature the most common failure factors in system quality (Doll & Torkzadeh, 1988; DeLone & McLean, 2003; Wixom & Todd, 2005; Petter et al. 2013).

3.4.1 Lack of reliability

The basic necessity of an IS is its continuous availability and accessibility. A system should be accessible regardless of location, platform or device. This has enabled the development of cloud-based services and virtual private networks. Use of cloud-based services significantly increases the success of IS use however, issues often arise when developing and implementing services and products (Al-Aqrabi et al. 2015).

The lack of reliability of a system shows how dependable an end-user can be of the system, in terms of measures such as uptime and downtime of the system (Srinivasan 1985; Wixom & Todd 2005). It is clear that organizations need reliable information systems that allow end-users (e.g. executives, managers, analysts) access to the high quality information for effective decision-making (Puklavec 2001). Nelson et al. (2005) found that reliability has the strongest effect on system quality when measured functionality with BI tools.

3.4.2 Ease of use

Ease of use or user friendliness as Doll & Torkzadeh (1988) identified by means of an incentive for voluntary managerial use of information systems has become a dominant measure in IS literature. This is reflected by the numerous studies pointing that software and web-applications rely on ease of use in order to satisfy the end-user (Gelderman 1998; Lee et al 2002; McGill et al 2003; Butler et al. 2007, Berthold et al. 2010; Petter et al. 2013). Systems can be very complex to an untrained user, therefore the necessary steps are required in order to improve the human interaction with the system (Lee et al. 2002). Especially when systems are heavily customised in house developed core systems that have been iterated over multiple years and organizational changes. Also evident by the growing number of studies about *ease of use* as a topic in the design of software process. The process is developed applying agile methods to each project or piece of software developed, allowing for the software to be tested ensure functionality both by developer and by an end-user during each iteration. This allows for a continuous feedback process that increases the end-user satisfaction.

3.4.3 Poor usage of infrastructure

Poor usage of the technical infrastructure can be caused by poor adaptability of an information system into the existing infrastructure. This is usually the case when multiple systems from different vendors or suppliers are implemented into an organizational IS (Chou & Han 2014). Systems offered by different vendors are often difficult to integrate with each other due to their rigid licensing structure. This lack of flexibility of the systems means that users cannot take full advantage of the infrastructure to carry out their tasks and cope with changes (Wixom & Todd 2005). Dijcks (2012) identified that in order to make most of big data, the organization must innovate and update their existing infrastructure to integrate existing organization wide data with the new high-volume, -velocity and -variety sources of data. Various studies have also found that business effectiveness is enhanced by successful use of IS infrastructure and use resource-based view to explain vital processes and resources by which IS infrastructures transform process into value (Melville et al. 2004; Garrido-Moreno, Lockett & Garcia-Morales 2014).

Therefore poor usage of infrastructure is a solid measurement of system quality as it encloses the aspect of how well the system has been designed, how usable the system is and how it fits technical design of the system. Yet it introduces a link between the systems compatibilities and specifications to organizational and environment factors.

3.5 Organizational Failure

Organizational capabilities or a lack of them, are by far the most common theme throughout the literature review. This is partly due to having combined IT strategy factors to other organizational factors, however as Butler et al. (2007) noted, not all critical success factors have equal influence on system failure. IS failure research has common artefacts with system success from a technological point of view, however the root cause is rarely of technical origin. IT is not only an infrastructure or technical platform but a mechanism that creates value and profits, therefore an integral part of the business level strategy (Drnevich & Crosson 2013). Garrido-Moreno et al. (2014, 1039) found out in their study on CRM technology infrastructures that organizational commitment no only acted as a relevant mediator but had the most direct impact on CRM success.

The cause of the failure is most commonly related to organizational and human psychological factors rather than technical (Lyytinen 1988; Ewusi-Mensah et al. 1991; Lederer & Sethi 1996; Jiang et al. 1999; Au et al. 2008; Deng & Chi 2013). Indeed, organizational issues were deemed most dominant factors that affected company’s decisions (Ewusi-Mensah & Przasnyski 1991). Therefore the organizational issues have been classified into sub-dimensions that register the most common factors leading to failure.

3.5.1 Change management failure

The ability to change organizational culture and manage general resistance to change prevails as failure factor throughout the researched literature. Markus (1983) noted that interaction between system characteristics and the social environment can cause user resistance, more specifically when change in intra-organizational power distribution leads through loss of power to resistance by end-users. As a solution, organizational change theory underlines that change can be tackled by preparation by for example implementing parallel information systems or increasing user involvement (Tait & Vessey

1988) rather than promoting loss of power. Therefore, the actual experience users have on the system features help them develop a view of threats that leads to resistance, provoking the thought that lack of training triggers resistance (Lapointe & Rivard 2005). In fact, Deng & Chi (2013) identified that users commit unintentional errors while using the system due to lack of knowledge about how to operate the IS (Deng & Chi 2013).

Li et al. 2012 sourced from an auditor's report that "lack of appropriate training of personnel throughout the organization causing system users to be less effective due to insufficient understanding of the systems they manage and depend upon" (p. 186). Consequentially it becomes apparent that the end-users lack of training affects the level of in which failure can be determined, as lack of training is rather an organizational failure than the system itself not functioning or having been designed incorrectly. Increasing user knowledge of the system and application processes is commonly agreed upon to be a critical success factor that cannot be overlooked in all phases of the software lifecycle (e.g. Ranier & Watson 1995; Saarinen 1996; Schmidt et al. 2006; Cecez-Kecmanovic et al. 2014)

As comparison, Akhavan & Pezeskhan (2014) found out that in KM projects most of the critical failure factors occurred in the sharing phase of KM implementation. This was a result of lack of motivation by workers to share their knowledge, which is bloodline of KM in general. The study identified other similarly important behavioural issues, such as conflict management and worker resistance to change, that all relate to fundamental issues how workers are being managed and how projects lack aggressive change management methods, especially in the implementation phase. By paying adequate attention to cross-functional configuration, testing of software and training of end-users could help diminish the amount of negative experiences in adopting new technologies. Similarly controlling and managing data legacy, reporting adequately and established in a recovery method for data input errors can cripple an adoption process (Markus et al. 2000, 262).

3.5.2 Project management failure

Avid project management in the development and implementation phases of an IS project is the backbone of a successful outcome. However, IS failure literature points out that poor project management is one of the main reasons IS projects fail. Even though project management is a wide topic that can cover the whole spectrum, this thesis focuses on the practical part of the project management. Under the umbrella term fall also the main constituents in which IS failure is measured, scheduling and cost management (Ewusi-Mensah et al. 1991). This argument rises from project managers setting unrealistic targets that easily escalate and affect negatively the continuation of the project (Montealegre & Keil 2000).

Firstly, the lack of leadership can have a radiating effect on how tasks are carried out. Unclear business objectives will require the team to work harder than required making the overall process inefficient. Carrying out processes in teams requires a multi-functional and talented team that can be easily managed according to the strategic technical framework of the project. Project teams have a responsibility to execute and simplify processes that then allow for easy execution and improved process development. Regular evaluation of project is also key to success, thus poor monitoring and review can result in a drastic escalation of project issues (Montealegre et al. 2000). By evaluating the project, managers have a better view that can be used to improve the communication and gain further input from top management, in terms of resources and personnel (Biehl 2007, 54).

Identifying the user requirements in project development stage could be thought to be a primary necessity for building an IS, however literature points out that lack of communication and interaction with end-users is a leading cause to project failure (Schmidt et al. 2001; Watson 2005; Biehl 2007; Cecez-Kecmanovic et al. 2014). Poor user participation is a significant cause to organizations incapability to improved system quality (Ives & Olson 1984; Barki & Huff 1985; Sabherwal et al. 2006). In fact according to reviewed literature there is evidence that the lack of user involvement is the leading cause to a failed project as the lack of awareness of the system aids the comprehension and reduces complexity (Lawrence & Low 1993; Jiang et al. 1999).

Interaction and communication in order to identify user requirements is also the basis of agile project management, leading software development and project development methods such as SCRUM.[19] Therefore, as mistakes are common in project planning, contingency plans are important in order to recover from mistakes and thus avoid failure (McManus et al. 2003, 17).

3.5.3 Top Level Management Failure

Even though problems during the IS design and implementation phase arise all around the organization it is the *Top* Management's role to overlook the project by being involved thus applying adequate risk management to prevent and solve the issues that arise, which are out of project managers capabilities. Hence the fact that management and executive issues are significantly more prominent than technical problems (Doll 1985). In fact as Davenport et al. (1998) identified, the more the project penetrates the organization the greater the executive support and commitment needs to be. Butler et al (2007) identified that workers respond to their managers requests, therefore if managers are not committed to the IS development or implementation, this will resonate to lower-level managers and other staff.

The active participation of executives in project development and implementation in terms of strategic planning, policy development and, decision-making lead by inability to guide were all major factors already realized by Doll (1985) in the early days of IS failure research. Lederer & Sethi (1996) similarly concluded that knowledge of resources needed and state of assets would highly increase the effectiveness of project preparation. Through preparation and top level management IT education a more fluid communication channel could be created. All in all the importance of top-level managers

[19] For a full review on agile project management method SCRUM – see https://www.scrum.org/Resources/What-is-Scrum

and executives knowledge about IT facilitates the communication between project levels. The effectiveness of communication is reflected through many articles, where the authors draw on poor quality of communication as per not understanding the project (Lederer & Sethi 1996; Schmidt et al. 2001, Garrido-Moreno 2014).

In fact, poor or total lack of communication during the design process between executives, end-users and developers can lead to a basic functioning system but fails to bring additional value to the organization, a point especially important in BI/BD. Therefore it can be said that system success, with relation to BI/BD is based on the capability of the system to offer a fluid continues value-adding experience. Noting that the definition of 'added-value' is to be identified by stakeholders: as developers view success from a technical point of view; end user from an ease of use aspect; and managers from a profitability stance. In addition, poor communication towards the project manager can have a rippling effect, especially when unsolicited changes in project requirements are introduced as they can push the development schedule and if not adequately managed can increase the cost of the project. This was verified also by studying project post-mortems (Pan et al. 2007) when interviewing executives that admitted their poor collaboration and communication with project managers.

Finally, drawing on the noticed trend of resource management and the lack of allocation of resources or incoherent distribution of resources reflecting in organizational inefficiency. A major setback is lacking an adequate budget to satisfy project management needs. However, it is to be noted that as one of the main failure measures is 'project went over budget', the financial allocation usually remains as a resolvable issue. Similarly Butler et al. (2007, 16) highlighted budget as not as a critical factor as top-level management tends to increased budget as necessary in order to complete the projects.

3.6 Environmental Failure

3.6.1 External Pressure

External pressures can result in changes in organizational structure due to poor performance against competitors and benchmarks. Consequentially, if the organizational structure changes, the new management might not agree on the perceived benefits of a new IS or the expected costs outweigh the perceived benefits (Ewusi-Mensah et al. 1991). This is because the new management focuses more on the value for financial aspect and therefore shifting the company culture (Cavaye & Christiansen 1996). Despite the fact that decision-making qualifies as an organizational factor, the context of continuous development of technologies can have an adverse effect on the decision making process for IS adaption and IS abandonment (Ewusi-Mensah et al. 1991) the pressure to adopt a new innovation in order to remain competitive can be devastating on existing IS projects.

On the other hand, the literature review brought to light that a common critical failure factor is the pressure exerted by the industry. This implies the necessity for companies to innovative in order to remain competitive. Such nature applied on developers of the systems, burdened by the continuous need to develop new systems and tightening of financial resources is an important measure to include in studies. In fact, the inclusion of technological newness as a critical success factor as a measure point (Jiang & Klein 1999). Therefore, it is evident that there is a lack of general knowhow about the understanding of the effects of IS processes decisions on surrounding environment and how to align strategy to solve the issues (Alter 2004).

3.6.2 Trust / Privacy / Third Party Service Providers

Decision-making processes should also include the opinion of the customer, as gaining perspective of their goals and needs is vital for a success operation. Alter (2004) discovered that governments exert pressure on banks having a direct effect on their decision-making process when carrying out basic processes such as bank loans. The pressure can be viewed from an economic and political point of view in which the government attempts to regulate certain transactions. It can also be viewed from the point of view of trust and privacy, in which stricter controls are to be present when handling customer data.

No single governance for data therefore sharing data such as healthcare data as in the case of the London Ambulance system (Beynon-Davies 1995). Similarly, Cavaye & Christiansen (1996) noted that banks fear sharing data with consultants due to the nature of data. Consultants and other third party service providers often interact with the given IS as many services such as e-commerce operators that need constant information sharing between end-user, IS and third party service providers.

In service failures such as e-commerce failures can result from end-user negative traits (lack of IT knowledge, language issues, state of mind etc.) and from individual level events (frustration, dislike, anger etc.) or system issues leading to incapability to operate (slow internet, language, internal errors etc.) can cause service abandonment or change of service provider. This change however is not actively the case in IS implementation projects due to the complex nature, timeliness and cost of choosing the service provider (Yeoh & Koronois 2010).

Evaluating or auditing the IS can also be carried out by the use of external consultants, that bring an external perspective, however companies can become wary about sharing the systems and relevant information outside company staff. There are some evident pitfalls of losing control of projects to external vendors. Common factors can be of a straight consequence of the lack of vendor commitment or ineffectiveness of the vendor to execute task by not associating adequate resources to the project, eventually causing slow implementation (Garrido-Moreno 2014).

Multiple vendors can lead to an ineffective development and implementation process as usually carried out by using external consultants. Relying heavily on consultants can lead to losing control of the project scope and miss objectives, thus resulting in additional costs and extended time frame (Schmidt et al. 2001). The literature points that the timeframe is a central role in disruptive innovation implementation project. This arises through the notion that organizations become pioneers in the market by reducing the time-to-market, enabling them to acquire an important slice of the untouched market.

3.6.3 First order constructs

In order to gain a fuller understanding of '*net benefits*' it is important to understand how IS expectations are formed. Expectations are studied in many fields associated with human behaviour and psychology, however information system sciences have witnessed an increase in popularity (Szajna et al. 1993; Staples et al. 2002; Au et al. 2008; Venkatesh et al. 2010). Szajna & Scamell (1993) offer an early working definition of expectation: "a set of beliefs held by the targeted users of an IS associated with the eventual performance of the IS and with their performance of using the system". This definition is used to clarify the concepts behind this thesis as understanding the user expectations of IS use is paramount.

Investments in to different IS' (ERP, BIS, MIS etc.) offer different uses and functions of the systems therefore different expectations of the outcome of the system are expected. Their main purpose is to facilitate the burden of human labour by producing organizations with timely, relevant and easy to comprehend and use information that can be used to analyse to support and improve managerial decision-making across the whole organization. (Elbashir, Collier & Davern 2008, 153). The expectations of the IS can also be identified through the different IS lifecycle stages. As developers are interested in the technological traits, as managers in the organizational benefits as well as financials, and the end-users have different expectations about how to system should function (Lyytinen & Hirschheim 1987).

Expectation can either be pre- or post- adoption where, pre-adoption expectation is an opinion or attitude that a user forms, prior to use, drawing from their previous experiences or from information acquired from an external source, and post adoption expectation gives the user a personal view. The belief or experience is then used in forming expectations about the IS (Oliver 1980, Bhattacherjee 2001).

There are two types of expectations when roaming in the field of IS. Explicit expectations consist of static, dynamic and technological, and interpersonal expectations that reflect what the user really expects to happen and are compared against targets.[20] They reflect what organizations really need and measure them against established standards. Implicit expectations on the other hand are influenced by externalities, such as measuring performance with other company's targets. (Miller 2000)

If the failure of an IS occurs, one of the key causes can be the lack of ability to meet stakeholder expectations (Szajna & Scamell 1993). The previously mentioned authors carried out an experiment using the cognitive dissonance theory, which draws on notion that disconfirmed expectations cause

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[20] Full explanation in: Miller, H., 2000, 'Managing customer expectations', *Information Systems Management*, vol.17, no.2, pp. 92–95.

psychological uneasy in the user. To overcome the unease (dissonant ideas) the user will attempt to deliberately lower the dissonance to achieve consonance (Kim 1990). According to a study by Lyytinen (1988) the profession, influence and dedication of the user has on the IS, affects greatly the expectations of the IS. Similarly, Ginzberg (1981) carried out a study on the realism of the expectations and discovered that realistic pre-implementation expectations resulted in a more satisfied system user, rather than the opposing. He also identified signs that user expectations can be used as an effective early prevention method for IS failure. In support of the previously mentioned, Staples, Wong & Seddon (2002) theorized that unrealistically high expectations would affect negatively the perceived benefit.

From the recent advancements in technology and a rise in marketing and competition between system providers, users are becoming more aware of what to expect from IS (Staples et al. 2002). The users can be divided into normal users and tech-savvy users, who in general demand for highly advanced IS compared to the normal user that expects the system to be easy to use (Miller 2000). According to the self-perception theory (Bem 1972) people continuously adjust their perceptions, therefore expectations, as they gather more information about the subject. This adjusted expectation is then reflected throughout the processes, therefore the initial expectation a user has can easily be distorted once the IS has been used.

Therefore, *perceived benefits* outline the users' perception on how the IS performance fulfils their prerequisites. Perceived performance influence pre-adoption expectations directly, therefore users that perceive the performance of an IS to be high, will have high expectations of the IS and vice versa (Oliver 1980, Yi 1990). The perceived benefits of big data for the organization can be identified using the TOE model, where technology identifies the perceived in/direct benefits, Organization context identifies the perceived financial costs and technical competencies, and Environment context identifies the industry and government pressures. Together these three factors will be used to draw the *perceived big data benefits* section. Mahmood et al. (2000) carried out a study where they introduced a theoretical framework for measuring end-user satisfaction. The results of the meta-analysis of various complied studies indicated that perceived benefits are measured by user expectations, ease of use and perceived usefulness (Mahmood et al. 2000).

3.7 Perspective of MIS Success

An information system can be considered as an organism that allows end users to create organizational value through exploitation of its given characteristics. The organism by itself does not generate value, but offers an enabling technical platform, which relies on the users' actual ability and willingness to use the technology (Au et al. 2008). Therefore, IS projects are aimed to improve an array of organizational sections, from enterprise wide systems to software development to data analytic systems and all have different measures of success. While there are some common and many less common measure points (see Table 3 in Appendix A), which need to be fulfilled to achieve success, there is a lacking consensus on actual success. Cost and time are the most used success measure points, yet a majority of projects go over budget and take longer than planned (See Table 1).

Therefore each project is to be evaluated by its own standards. Davenport et al. (1998) analysed KMS success factors that '*contributed to their effectiveness'* (p. 50) as organizations would measure changes in business such as growth of resources, increase in volume of resources, financial return from a perceptual point of view and chances of project survival, as survival can also be a measure of success. This implies that the basis for the success of an IS is its actual use, which is also reflected in the DMSMM. *IS use* as a measure of IS success has received some criticism as the validity of the statement was put in question. Variables by themselves cannot lead to a holistic success measure as for example; system success cannot be drawn solely from information quality. As Mirani & Lederer (1998) define the outcome as '*net benefits*', they imply that the factors that impact system success are grouped together in the model. Seddon (1997, 250) argued that '*system use*' is not a valid variable to measure IS success due to the fact that it is considered as behaviour rather than a measurable variable. In fact, Szajna (1992, 153) stated that assumption that heavy use of a system means that the system is successful, is not necessarily valid in all cases, but rather that critical factor for IS success should be '*net benefits'* that come from the effective use of the system.

To measure the net benefits in an ideal situation would be carried out in a pure numerical and monetary form where the costs and profits reflect the system benefits (Wu et al. 2006). However, IS' exist in changing environments (Ives et al. 1980) where different variables can influence the benefits. For this reason measuring the direct net benefits is complicated and can become subjective. Wixom & Watson (2001) also noted the discrepancy that the benefits are merely perceptions and suggested that 'perceived system benefits' is to substitute 'system benefits' as measure of IS success.

There are two contrasting models which are used to measure the success of an IS. The first is a process model that suggests that the satisfaction or dissatisfaction is influenced by use of the system. The second model is a casual model that is based on expectations; such as superior system quality leads to increased use and higher satisfaction. In fact, the D&M SSM assumed linear causality between the impact and user dimensions. However, Seddon (1997, 250) drew on the notion that system use is a behaviour reflecting expectations of system benefits. Therefore, deeming the relationships confusing as it tangles processes with casual to follow the impacts and benefits, rather than causing them. Hence, system use is an essential, however not ample enough measure to generate system benefits (Gelderman 1998).

Finally, using a combination of methods to measure system success in an organizational setting has been encouraged since the development of DSS, therefore combining system use and user satisfaction would amount to a more accurate result (Barki & Huff 1985). IS success literature resonates similar factors that can be classified into the T.O.E. framework. To rend the classification system more compatible with BD & BDA attributes, which include the six V's are integrated into information quality and system quality. Similarly to the failure model organizational issues reign over success literature.

4 RESEARCH IMPLICATIONS

The purpose of this final chapter is to highlight practical implications and discuss the implications for theory and. Finally, the research limitations and further research opportunities are discussed.

4.1 Implications for Theory

In the theme of the thesis, the creation of information from data is vital for organizational evolution (Watson et al. 2007, Wixom 2010). Likewise, the production of new information, models and concepts in the research of a field of study adds to the knowledge base. This of course is derived from the collection of literature reviewed (See Table 1) that evidenced the lack of focus into big data as topic of IS failure.

Firstly, this thesis gives contribution to extant literature on big data and big data analytics as a topic of IS failure. Even though success as a topic has been extensively studied within the field of IS, (DeLone & McLean 1992, 2003,) through comparison there is a clear discrepancy in the extensity of research into IS failure.

Second, having selected the T.O.E framework as the main model to analyse and categorize the literature, the thesis has supported Tornatzky and Fleischer’s (1990) original model by demonstrating its efficiency for fathering critical indicators (for both success and failure) and thus complementing to its practicality as a framework. By successfully drawing from the TOE framework enabling a logical new framework to be constructed both adds to its validity as an establish theory as well as its practical usage in IS studies.

Third, big data success and/or failure as a topic have received close to no attention from academic researchers. Therefore, by capturing ideologies from extant business intelligence success literatures, this thesis places big data failure as a topic into the growing stream of IS research. By drawing from established ideologies (e.g. Zhu, Kraemer & Xu 2003) the theoretical knowledge base is widened.

Fourth, the latter part of the thesis focused on identifying critical factors leading to information system failure. The factors were noted from a technology, organization and environment stance, offering a solid, theoretically proven framework that can be used as a classification system for big data failure. Even though, this framework that was developed by borrowing from existing IS models, it provides a solid scale that can be used to for further research purposes.

Finally, following the current industry environment, IS are diverging from a traditional setting towards a cloud based environment and therefore allowing for organizations to become more versatile, cost effective and efficient. This lessens the burden many companies have to place on developing systems, however increases the responsibility of the project management and change management teams within the organizational structure. Therefore, this confirms that organizational theory is a key theoretical part of organizational development and should be further investigated also within the adoption processes of disruptive innovations.

4.2 Implications for Practice

There are several practical implications of this research. I direct the implications to big data vendors and companies who use big data. The developed IS failure model offers users guidance on how to approach and evaluate the acquisition and adoption process.

Initially, the framework can be used as a guide to companies who use big data identify critical failure factors. More specifically, the proposed model helps to identify the main characteristics in each T.O.E dimension and sub-dimension.

According to reports by Gartner (2013) general organizational IT spending will continue to increase since the slump in 2009. In support of this notion, analytics and business intelligence was identified as the number one priority in digital technologies for CIO (Gartner 2013), which also encloses big data technologies. A large skill gap in enterprise architecture was also found to be the main cause of worry for organizations as it radiates negative impact on the business, also concurring with the results of this thesis. This implies that the competitive platform is rapidly developing and organizations have to re-think their strategy as legacy systems will require updating or replacement and change management will force new IT systems to be introduced.

Then, the scales can help measure different aspects of big data utilization in the company. For example, checking the mean value will help managers in aiding important decision-making processes regarding adoption, implementation or use of the IS.

4.3 Limitations & Future research

There are several limitations to this study that may serve as the avenue of further research. A theoretical framework was developed by thoroughly examining and evaluating prior literature, however it could be argued that some journals beyond the '*basket of eight'* could be deemed relevant and thus included in to the scope of the study. This opens an opportunity to expand the study across other sources. Having considered this, as per the nature of this conceptual study, no empirical data was collected to be used to statistically validate the model. This presents an obvious opportunity for future studies using the failure model by associating it with data and validating the model using statistical analysis.

First, in addition to the numerous thought-provoking topics touched in this thesis, big data still remains as the central point to focus further studies on. The disruptive nature of big data opens up a myriad of opportunities that arise with the continuous development of the technology allowing it to grow across industries and enable the extraction of the potential value locked in organization IS and the data streams. The industry independence nature allows for big data as a topic to be studied from a wide range from aspects and easily linked with individual business case studies to then aim to gain a deeper understanding into an industry and further to investigate individual components of a larger system landscape.

Second, by expanding the field of study by collecting data from different industries can validate our model. Comparing business intelligence and big data system adoption in different industries can give new insight. This theme of research will also identify the synergies and differences of big data usage across industries. Discovering the difference between technology-focused companies to say resource companies, the use of the technologies have a varying effect. This is especially interesting as the Internet of Things has massive growth potential in the industrial sector, through intelligent sensors.

Finally, it is a general notion that business organizations benefit from data analytics such as business intelligence and big data, however this topic remains mostly unstudied from a theoretical stance nor empirical measured. Another imminent topic of discussion involves around expanding the knowledge base by creating information and knowledge from data gathered inside from organizations own data sources, however this leads to the question if internal sources are more reliable and beneficial than external sources. This is in regards to the data collection process and the boundaries the environment exposes to it. As identified (table 2), data privacy is a critical factor to be taken into consideration. Thus, future research could also investigate the ethical considerations that the companies follow in collecting, storing and using data. Especially, following the prediction of increasing data collection from uprising devices such as wearable technologies and e-healthcare.

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6 APPENDIX A

Table 3 - IS success literature

Authors	Source of Application	[Dimensions] + (sub dimensions)
Al-Aqrabi et al. 2015	Cloud BI	**Technological** [Information quality] (Quantity, accuracy, data Presentation (sorting, charting, colour coding, multidimensional interactive features)) [System quality] (reliability, ease of use, availability, response time, security] [Service quality] (support, infrastructure maintenance) **Organizational** [resource elasticity, cost efficiency, flexibility, enhanced data sharing, support]
Bajwa et al. 1998	Executive IS	**Organizational** IS support, Top management support
Barton & Court 2012	Big Data	**Technological** [Information quality] (Multiple data sources, relevant data) [System quality] (Complex analytics models, ease of use, merging of data, infrastructure) **Organizational** (Management dedication, resource alignment, skilled staff)
Chae & Kim 2002	Mobile internet Services	**Technological** [Information Quality] **(**Objectivity, Believability, Quantity, Structure, Presentation, Timeliness, Promptness)
Chao-min et al. 2007	e-learning system	**Technological** [Information quality] (Accuracy, completeness, ease of understanding, relevance) [System quality] (Availability, ease of use, reliability, response time, Frequency, time of use)
Chung et al. 2005	Business Intelligence Systems	**Technological** [Information quality] (Accuracy, relevance, quantity, Content collection, text mining, document visualization) [System quality] (Web mining, Clustering, visualization techniques)
Cumbley et al. 2013	Big Data	**Technological** [Information Quality] (Quantity, Accuracy, retention, Privacy) [System Quality] (System security) **Environmental** [Trust/privacy] (Data Protection Law, Data Protection Directive)
DeLone & McLean 1993	IS success model	**Technological** [Information Quality] (Accurate, timely, complete, understandable, relevance, personalisation), [System Quality] (Adaptability, Availability, reliability, response time, usability)
DeLone & McLean 2003	IS success Model	**Technological** [Information Quality] [System Quality] **Organizational** [Use, User satisfaction, Individual Impact] **Environment** [Organizational Impact]
Fadiya et al. 2014	Big data	**Technological** [Information Quality] (Data Variety, velocity, volume, veracity) [System Quality] (Platform accessibility)

Fitzgerald & Russo 2004	Computer Aided Dis-patch system	**Technological** [System quality] (adequate prototyping and testing, staged development) **Organizational** [Change Management] (end-user training) [Project Management] (Use of skilled and experienced developers, Realistic project timeline) [Top level Management] (adequate participation, strategic vision, dedica-tion, trust bet, adequate budget, org wide focus on project), **Environmental** [Trust](between suppliers/consultants and own staff)
Hostman 2007	Business In-telligence Systems	**Technological** [Information quality] (Accuracy, Quantity, Correlation, Privacy, Anonym-ity)
Khan and Quadri 2014	Business In-telligence Systems	**Technological** [Information Quality] (Data quality, data timeliness) **Organizational** [Change management] (Readiness to identify value) **Environmental** [External pressure] (Rapid change through innovation)
Marin-Ortega et al. 2014	BIS / Big data	**Technological** **[**System quality] (performance, Robustness of existing BIS, Capability of handling Big Data)
McAfee et al. 2012	Big Data	**Technological** **[**Information Quality] (Quantity, Data Variety, velocity, volume, veracity, correlation, causation, relevance, presentation, visualization) [System qual-ity] (Integration to existing infrastructure) **Organizational** [Top Level Management](Leadership, Decision-making, Flexibility, Skilled staff) **Environmental** [privacy] (ensuring data privacy)
Popovich et al. 2014	Business In-telligence Systems	**Technological** [Information quality] (Accurate, reliable, Timely, relevant, usefulness) [System quality] (adaptability) **Organizational** [Change Management] (Information access, Intention of use,) [Top Level Management] (Executives central role, strategy implementa-tion) **Environment** [External Pressure] (Highly competitive, data from external sources)
Puklavec et al. 2014	BIS Adoption success	**Technological** (Innovation, Readiness) **Organizational** (Characteristics, Collaboration, Features, Management, Resources) **Environmental** (Competitors, Industry and Market, Suppliers, Partners, Providers, Regulators)
Rubin & Rubin 2013	Business In-telligence Systems	**Technological** [Information quality] (Accuracy, Timeliness, Quantity, Correlation) **Environmental** [Privacy]
Russom 2011	Big Data	**Organizational** [Change Management] (Enablement of cost effective management, re-source control, forecasting) **Environment** (External threat elimination, Privacy screening, fraud detection)
Sabherwal et al. 2006	IS success Model	**Technological** [System Quality] (perceived usefulness, user satisfaction, system use) **Organizational** [Project Management] (User experience, User training, User attitude, User participation)

		[Top level management] Top level support, facilitating conditions for IS success,
Schneider et al. 2005	Business Intelligence Systems	**Technological** [Information Quality] (Timely, accurate) **Organizational** (Cost (reduce multiple data entry and therefore errors)
Seddon et al. 2010	ERP	**Technological** [Information quality] (Timeliness, accuracy, relevance) [System quality] (Availability)
Szajna & Scamell 1993	Cognitive dissonance theory	**Technological** [Information quality] (Quantity, response time, accuracy) **Organizational** [Project Management] (Age of company Level of MIS manager, , System initiator, management support, training, user involvement, quality of IS staff, User/analyst relationship, organizational sophistication, IS experience)
Wang & Liu 2009	Business Intelligence Systems	**Technological** [Information Quality] (Data Management - extraction, cleaning, integrating, storage and maintenance) (Data Analysis - queries, reports and data visualization) (Knowledge Discovery -extract knowledge or intelligence from huge data sets)
Wang et al. 2013	Big Data	**Technological** [System Quality](Scalability, Lower costs by efficiency in query response, decision making support)
Watson et al. 2006	Business Intelligence Systems	**Technology** [Information Quality](Data Latency, Analysis Latency, Decision Latency**,** Real time data sources) **Organizational** [Project Management] (Clear definitions for organizational processes, readiness for change)
Watson et al. 2002	Business Intelligence Systems	**Technological** [Information quality] (Ease of use, Timely, relevant, accuracy, reliability) [System quality] (Availability, accessibility, Usability, flexibility, adaptability, response time)
Wixom & Watson 2001	Data warehousing	**Organizational** [Change management] (user participation) [Project management] (skilled project team) [Top level management](Management support, adequate resources)
Wixom 2010	IS	**Technology** [Information Quality] (Data Infrastructure, data governance, data quality) **Organizational** [Top level management] (Executive and top managers support, Strategic vision, skills to execute, analytical culture, skilled users) **Environment** (Highly Competitive, communication with customers)