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Designating Legacy Status to IT Systems

A framework in relation to a future-oriented perspective on legacy systems

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This thesis is submitted in partial fulfilment of the requirements of the degree of MSc in Informatics at the International Business School of Jönköping University, Sweden (Henceforth JIBS). The paper presents a research on legacy systems performed in cooperation with KPMG Advisory N.V. the Netherlands (henceforth KPMG). Research was carried out from January till May 2016 at the department of Technology Advisory (Henceforth TA). Joost Koedijk, the designated partner at TA, has been active in the field of software engineering for years with legacy systems as one of his main areas of expertise. Koedijk recently published a study on legacy systems in the public sector in the Netherlands. This research is performed in continuation of that study.

Numerous people contributed to this document. I would like to express my gratitude to Dennis Stam for his time and support. Your critical and straightforward feedback has been of great help in conducting this research. My appreciation also goes out to Joost Koedijk for providing valuable insights that motivated much of this research. I would like to thank Daniela Mihailescu as well for keeping me on the right track. Last - but certainly not least – I would like to thank all John and Jane Doe’s that participated in the survey. Your responses have been an indispensable source of data in answering the research questions.

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Abstract

Organizations that have come to depend on legacy systems face quite a paradoxical problem. Maintaining the system might prove ineffective in accommodating necessary changes, but a system migration project is expensive and incurs a high amount of risk. Organizations are therefore hesitant to respond to the legacy system problem by undertaking action. Legacy system are often not causing their organization any problems at present, but a focus on the future with regard to the legacy system problem is lacking. This results in IT systems reaching an end-of-life state. The research therefore set out to explore a future-oriented perspective on legacy systems by means of observation, a literature review and a survey. The researcher found the key concept of a future-oriented perspective to be that any system that is limiting an organization to grow and innovate can be regarded as a legacy system. A framework to designate legacy status to IT systems is proposed in order to guide practitioners to acknowledge a problematic IT system to facilitate appropriate response at the right time. In relation to a future-oriented perspective, when to designate legacy status is best determined according to the system's flexibility towards change and the alignment of the system with the business. In that regard, IT systems are end-of-life systems when they are too inflexible to change, and as a result become unaligned with either current operations or a future business opportunity or need.

Keywords: legacy systems, legacy status, future-oriented perspective, system change, business & IT alignment, legacy system characteristics.

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1 Introduction

This chapter presents the context of the study. It introduces the background of legacy systems and the problem that motivates the study. It then sets out to explain the purpose of the research followed by the questions the study will aim to answer. Relevant delimitations and key terms are then discussed. A disposition of the paper can be found at the end of this chapter.

1.1 Background

Until the 1990s most computer programs were designed to truncate a four-digit year to a two digit year in order to save memory space. Coming closer to the year 2000, it was recognized this would result in a bug as “00” can indicate both “1900” and “2000”. Failures because of this misreading were expected to have the potential to lead to widespread chaos. After all, these programs support failure sensitive industries like the banking, health and public sector. The world worked feverishly on solving the Y2K problem, or millennium bug, investing an estimated $300 billion in possible solutions. The media was filled with reports of relief when it became clear that first day in January 2000 that most organizations had succeeded to debug their software. (The Editors of Encyclopaedia Britannica, 2014)

Organizations operate in a dynamic environment that requires flexibility and adaptability towards a rapidly changing marketplace (Cosentino, 2013). Much of today’s operations are supported by computer systems, making these systems an ubiquitous aspect of our society (Sommerville, 2011). Computer systems are required to change along with the dynamic environment they support. The millennium bug is a good example of the need for the ability of systems to change. It is not without reason either that Lehman’s first law concerning system change states that maintenance is an inevitable process (Lehman, Ramil, Wernick, Perry, & Turski, 1997). An organization might want to explore new opportunities or change its business goals (Warren & Ransom, 2002). In addition, technical triggers like fault repairs, functionality requirements and environment adaptation can cause computer systems to change as well (Sommerville, 2011).

On top of that, developing a computer system can be a large investment. Naturally organizations operate these systems for as long as system maintenance allows it in order to maximize return on investment (Sommerville, 2011). The process of system maintenance has led to computer systems surviving not only years but decades. Nowadays, early adopters of IT operate systems that have been developed as many as 30 years ago (Seacord, Plakosh, & Lewis, 2003). The longer a system lives the more an organization can come to depend on it, and vice versa. Such old but business critical systems are referred to as legacy systems in most literature. Organizations that have come to depend on legacy systems face quite a paradoxical problem.

Legacy systems are tried and tested and thus dependable systems for executing daily operations. In addition, system migration projects are costly, complex, lengthy and have a tendency to fail. This puts forward a significant amount of risk to organizations considering to undertake such a project. Vital information could be lost, and daily operations disrupted, while monetary resources are going down the drain. On the other hand, system maintenance is not without risk either. The expense of maintenance can be excessively high too, and it could proof ineffective in accommodating necessary changes. Documentation related to these systems is often half-done, and experts with legacy system knowledge are scarce. In addition, technologies used in legacy systems are more inflexible and less efficient than modern technologies. This is the legacy system problem. (Khadka, Batlajery, Saeidi, Jansen, & Hage, 2014; Warren & Ransom, 2002)

Unless a legacy system remains flexible towards change in order to stay aligned with the organization it supports, it will increasingly become more of a burden than a benefit to organizations. As Matjaz Jug puts it: “*The Legacy problem is like global warming. Some people don’t believe there’s a problem at all but the ones who do know that it won’t go away by itself, it will only get worse*” (McDavitt, Jug, & Vanderburg, 2008, p. 3).

1.2 Problem Statement

In response to the legacy system problem, Koedijk recently published a study on legacy systems in the public sector in the Netherlands (2015, co-author: H. Donkers). Koedijk and Donkers offer advice on how to make the IT-environment future-proof. "*In reality a lot of organizations are just fiddling around, without a clear perspective on fundamental improvement*" (Koedijk & Donkers, 2015, p. 12). Therefore, they suggest a three step process towards solving the legacy system problem. Step one revolves around creating a clear understanding of the legacy system domain. "*Legacy system is often used as an all-purpose word, but a clear view of what is going on is missing. In order to solve a complex problem it is necessary to establish what that problem comprises … this starts with a clearly delineated view of what a legacy system is.*" (Koedijk & Donkers, 2015, p. 4-5). In the second step Koedijk and Donkers urge on the necessity to have a clear view of the future. "*Those who put effort in delineating the problem can then create a clear perspective on the desired future of their IT environment*" (Koedijk & Donkers, 2015, p. 13). If step one and two are established, the legacy system problem can progressively be solved in step 3. "*A sharp vision of the future guides new IT projects and can help prevent that new legacy systems are created*" (Koedijk & Donkers, 2015, p. 4). In continuation of Koedijk and Donkers' research, the following is observed with regard to the just described steps.

Academic literature offers different views on what a legacy system is. Alderson and Shah (1999) summarize all views into four perspectives with each a key concept. The perspectives are contradictory because the key concepts oppose each other. Where one perspective's key concept is that every system in production is a legacy system, another's key concept is that only old systems with obsolete technologies are legacy systems. As a result, there is no standard definition for legacy systems and disagreement of opinion exists. Alderson and Shah' perspectives do not distinctively acknowledge the future-focus that Koedijk and Donkers (2015) urge upon. Instead, they integrate a future aspect into their organizational perspective, which is focused on computer systems supporting current business operations in support of the business strategy. Since Alderson and Shah (1999) do not distinctively describe a future-oriented perspective, the key concept of such a perspective is missing.

This lack of focus on the future with regard to legacy systems is problematic (**problem 1**). "*Legacy systems are not a problem of the past, but a problem of the future" (*Koedijk & Donkers, 2015, p. 3*).* The legacy system paradox makes most organizations hesitant towards taking action. Because legacy systems are not necessarily causing problems at present, the moment when an organization should start responding to the legacy system problem is easily missed. It is impossible to pinpoint the exact moment when a system can be regarded as a legacy system. After all, the transition from regular system to legacy system does not happen overnight. Nevertheless, "*conferring legacy status is essentially a strategic consideration … facilitating appropriate response*" (Alderson & Shah, 1999, P. 116). Organizations are having trouble to identify the right moment to designate legacy status to their systems, and thus the right moment to undertake action (**problem 2a**). As a result, they often find the system in an end-of-life state. That is, a critical situation where an organization is heading for disaster, e.g. in the form of a failing business vital system (Tromp & Hoffman, 2003). For end-of-life systems an organization often has no other option left than to migrate to a new system.

Weisert (2009) argues a long list of characteristics is usually mentioned when talking about legacy systems. Yet, characteristics are unstructured and often not per se unique for legacy systems. For example, a defining characteristic of legacy systems often mentioned in literature is complex. Yet, it can be argued that a complex system does not necessarily have to be a legacy system. This principle of characteristics being applicable for both regular systems and legacy systems holds for most characteristics mentioned in relation to legacy systems. Characteristics thus do not offer much guidance in determining when a system can be regarded as a legacy system. To the best of the researcher' knowledge there is no tool available to guide organizations to designate the legacy status to computer systems (**problem 2b**). Without a focus on the future with regard to the legacy system problem, and no tool to provide guidance in designating legacy status to computer systems in order to respond to the problem at the right moment, organizations will continuously keep finding their systems to be end-of-life systems.

1.3 Purpose of the Research

The purpose of the study is twofold. On the one hand, the purpose is to provide insight into the key concept of a future-oriented perspective on legacy systems. On the other hand, the purpose is to create a framework that can guide organizations and practitioners to designate the legacy status to computer systems. Two main purposes result in two research objectives with their own aim.

Koedijk and Donkers state that legacy systems are a problem of the future, indicating the need for future-focus and therewith the need for a distinctive future-oriented perspective. While this statement is supported by other literature, it is unclear what such a perspective would entail, i.e. what the key concept of such a perspective would be. The first objective of the research is to explore the key concept of a future-oriented perspective on legacy systems in order to verify whether such a perspective is significant. Lovitts and Wert (2009) define significance as something that will have an impact. The aim of this research objective is to contribute to current knowledge on legacy systems by providing an alternative view on what a legacy system is. This should enhance the four perspectives offered by Alderson and Shah (1999), and cause those inside and outside the field of legacy systems to see things differently; thereby creating an impact.

Characteristics of a legacy system can be derived from academic literature. The long list of characteristics is rather disorderly since not all characteristics are per se unique for legacy systems. The second research objective is to identify the characteristics that are unique for legacy systems in relation to a future-oriented perspective on legacy systems, i.e. legacy system properties. A causal relationship is detected where the remaining characteristics seem to be factors influencing these properties. Characteristics will therefore be organized into factors and properties in order to structure them into a relevant framework as mentioned above. Relevance is defined as generating something that practitioners find useful or insightful (Panda & Gupta, 2014). The aim of this research objective is to address a problem that is of concern to practitioners by providing a tool that can be utilized in the field. While designating legacy status is to facilitate appropriate response, this should prevent practitioners and organizations from ending up with end-of-life systems.

1.4 Research Questions

Based on the research objectives, the study will answer the research questions (RQ) below; with the first research question relating to the first research objective, and the second question to the second objective.

RQ1: What is the key concept of a future-oriented perspective on legacy systems?

RQ2: What are the properties of a computer system fundamental for determining whether or not a system can be regarded as a legacy system?

1.5 Delimitations

With regard to the scope there are certain delimitations to this study. In this research legacy systems are studied from an IT management or business perspective. Although technical aspects that are deemed relevant will be taken into account, the study will not go into depth on the technical side. For example, a detailed analysis of architectural pattern usage in legacy systems is considered out of the scope of this research. Subsequently, the study will not aim to offer a solution to the legacy problem by means of developing a method to migrate legacy systems.

The research acknowledges that different and contradicting perspectives are acceptable to define legacy systems. A delimitation to this study is that the developed framework does not correspond with all perspectives on legacy systems. Designating legacy status depends first and foremost on what one considers a legacy system to be. The framework is developed in relation to a future-oriented perspective and constructed based on the generic list of characteristics derived from academic literature. A strict relation between perspectives and characteristics is not sought after.

1.6 Key Terms

Computer System: a system is a set of interdependent and interacting parts that together form a whole. A computer system is the combination of non-technical parts (business rules, business processes, and humans) and technical parts (hardware, software, and peripheral devices) that can each operate independently but also communicate with each other through an interconnected network. (Barata & Cain, 1999; Sommerville, 2011)

Note that in this paper the terms computer system, IT system and simply system are used interchangeably. Legacy system and legacy information system are also considered synonyms.

System Change: adaptation of a system to its environment, for instance to respond to changes, increase functionality or decrease complexity (Lehman et al., 1997). Note that system change involves a system being flexible towards significant changes, such as changes in architecture or functionality, rather than small maintenance (Sommerville, 2011).

System evolution or modernization is considered synonymous for system change. Software and system maintenance or modification indicate the process of change rather than the concept of it.

Business and IT Alignment: "*the continuous process of preserving coherence between business and IT strategies"* (Baïna, Ansias, Petit, & Castiaux, 2008, p.1) through communication, trust, leadership and understanding (Luftman, 2004).

The paper employs the terms characteristic, factor, property and key concept. Note that each has a specific terminological use in this paper.

Characteristic: the Cambridge Dictionary defines a characteristic as "*a typical or noticeable attribute of something*". Most legacy system characteristics apply for regular IT systems too. Therefore, characteristics are structured based on a causal relationship where some characteristics (*factors*) are not unique for legacy systems, but influence other characteristics (*properties*) that are unique for legacy systems:

- **Property**: the attributes of a system that are considered fundamental for determining whether or not that system can be regarded as a legacy system, i.e. the characteristics unique for legacy systems. Massive size is an example of a *characteristic* of an IT system that is a *factor* influencing the system's *property* of flexibility towards change, i.e. it is assumed only legacy systems are inflexible towards change.

- **Factor**: those attributes that are considered not to be unique for legacy systems per se. That means these characteristics are applicable for a legacy system as well as a regular system. For example, both a regular system and a legacy systems can be vital to the organization they support or have bad documentation.

Key concept: the key concept of a perspective is the core idea of what that perspective considers a legacy systems to be. In the strategic perspective, for example, a legacy system is a system where costs trump benefits in a cost-benefit analysis. The key concept distinguishes one perspective from another and makes each perspective relevant, i.e. each key concept offers a different view on what legacy system is within the broad definition of legacy systems.

1.7 Paper Disposition

This chapter addresses the introduction towards the research topic. For clarification purposes an overview illustrating the research problems and objectives in relation to the terminological use of the words key concept, characteristic, factor and property is provided in Appendix 1. The reader is recommended to consult the appendix before continuing to read this paper. The remainder of the paper is arranged according to the structure depicted in Figure 1.

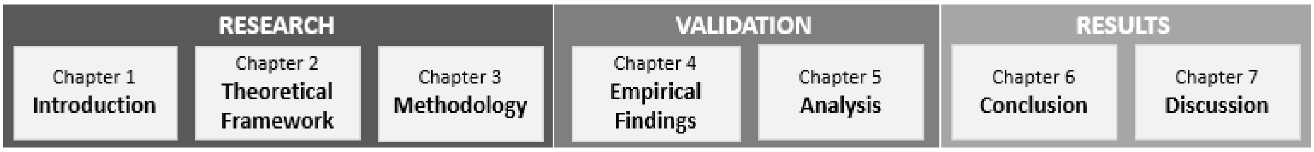

Figure 1 – Reader's Roadmap

Chapter 2: The relevant literature for this paper is framed in chapter 2. The theoretical framework includes theory about the components of a computer system, the characteristics of legacy systems, and the perspectives on what a legacy system is. Concluding chapter 2, a conceptual framework including working hypothesis is provided. Where different perspectives on legacy systems are acceptable, the conceptual framework provides the reader with the paper's position on what a legacy system is. It also shows the constructs the researcher wants to investigate and the relationship between these constructs.

Chapter 3: How the constructs in the conceptual framework are investigated is discussed in chapter 3 where the employed research methods are described. In this chapter the research philosophy, the research approach, the research design, data collection, data analysis and the quality of the research are discussed in that specific order.

Chapter 4: The conceptual framework with working hypothesis is verified by means of a survey. Empirical findings collected with the survey are displayed and discussed in chapter 4 according to graphs and figures. The chapter introduces the reader with the demographics of the respondents in the survey, the empirical findings in relation to the future-oriented perspective, and the empirical findings in relation to the factor-property structure of legacy system characteristics.

Chapter 5: The empirical findings are analyzed in chapter 5. Variables will be analyzed in relation to each other and in relation to the literature framed in chapter 2. The first part of the chapter revolves around the key concept of a future-oriented perspective. The second part of the chapter around the framework to designate legacy status to IT systems. Whether the working hypothesis is accepted or rejected is discussed in this chapter as well.

Chapter 6: In this chapter an answer will be provided to the research questions and the study will be concluded.

Chapter 7: Provides the reader with a discussion on the contributions of this study according to significance and relevance, the limitations to this study, and the recommendations for further research.

2 Theoretical Framework

This chapter contains the literature on which this study is based and from which the author derives assumptions. The chapter revolves around a discussion on the definition and characteristics of a legacy system according to components, issues, and perspectives. The chapter is concluded with a conceptual framework that forms the basis for further research in this study, and structures the chapters on empirical findings and analysis accordingly.

2.1 Computer System Components

There are different gradations of computers, ranging from powerful multi-user mainframes to small single-user personal computers (Barata & Cain, 1999). Linking a computer to a network assures that data can be exchanged between computers and peripheral devices, i.e. any auxiliary apparatus that is not a fundamental part of the computer but rather an enhancement (Barata & Cain, 1999). According to Barata and Cain (1999) a computer system consists of several parts that interact with each other in order to accomplish a fully working system. Figure 2 illustrates these parts and the relation between them.

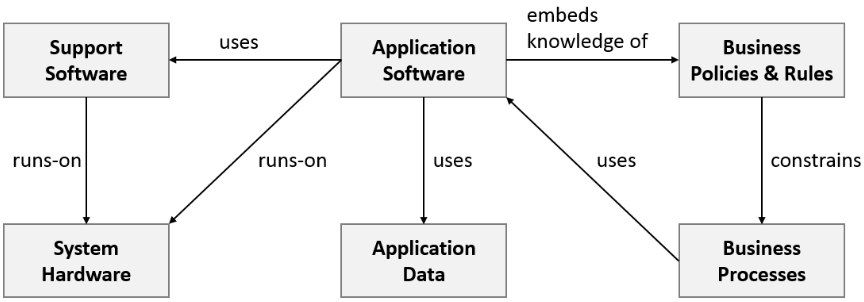

Figure 2 - Computer System Components (Sommerville, 2011)

An essential part of the computer is the system hardware on which support software and application software run (Sommerville, 2011). System hardware is the tangible equipment like memory, CPU, or a storage device (Barata & Cain, 1999). Software, on the contrary, is the programs or instructions that are operated by and stored on hardware (Sommerville, 2011). According to Barata and Cain (1999) there are two distinctive kinds of software; support software and application software. Support software, or system software, includes all software that provide services to application software in order to make the computer work. An important aspect of support software is the operating system. The operating system manages hardware and software through services such as supervising installation, controlling functions, and allocating resources. Application software are self-contained programs that allows users to carry out a specific task for their work, e.g. word processing or communication applications. Application data is the representation of information in a formalized fashion suitable for communication, interpretation, and processing by computers (Sommerville, 2011). Note that data is not the same as information. Data becomes information when it is put into context through interpretation and processing (Zins, 2007). Warren and Ransom (2002) distinguish between fixed or unchanging static data and changing dynamic data.

Non-technical components of a computer system are business rules and business processes (Sommerville, 2011). A business rule is an abstraction of organizational practices that are embedded in a computer system with the intent to influence, control or constrain behavior (Boyer & Mili, 2011). Through governing behavior business rules automate business processes. A business process is a flow of structured activities that turn an input into an output (Sandkhul, Stirna, Persson, & Wißotzki, 2014). Business processes are often in part reliant on computer systems for execution. Another component of a computer system is interfaces. "*An interface is a boundary across which two independent entities meet and interact or communicate with each other*" (Bachman et al., 2002, p.2). This kind of exchange can be between hardware, software, peripheral devices, humans, and a combination of these. An interface is thus all-encompassing, and hence not included as a separate entity in Figure 2.

2.1.1 Business and IT Alignment

More than just a combination of components, a computer system has a human, social and organizational aspect, i.e. people who operate the computer and organizations that use the outputs that computers create (Barata & Cain, 1999; Sommerville, 2011). Humans and organizations together with technical- and non-technical aspects form the whole of a computer system. For this reason computer systems are regarded as socio-technical. Because 'socio' and 'technical' are two equally important aspects in computer systems, the alignment of these aspects naturally plays a large role. Business and IT alignment is defined as "*the continuous process of preserving coherence between business and IT strategies"* (Baïna et al., 2008, p.1). To achieve alignment good relationships, trust, leadership and effective communication are required, as well as a deep understanding of the business and technical environments (Luftman, 2004). A model accepted as a de facto standard for business and IT alignment is the Strategic Alignment Model developed by Henderson and Venkatraman.

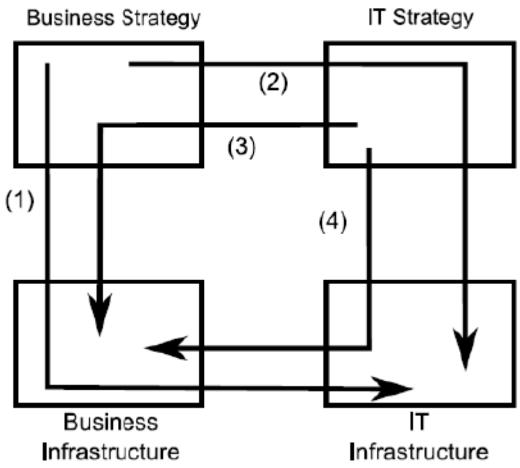

Figure 3 - Strategic Alignment Model (Baïna et al., 2008)

The model (Figure 3) illustrates four different views on how IT can be aligned with the business. The first view, strategy execution, is in accordance with conventional strategic management. Here, IT infrastructure is designed based on business strategy choices and business design. IT simply supports the business. The second view, technology potential, involves the formulation of a separate IT strategy. This IT strategy should be coherent with the business strategy, and IT is still meant to support the business. In the third view, competitive potential, it is acknowledged that IT capabilities can have an influence on the business strategy. That is, the business strategy can be modified based on emerging IT capabilities. Rather than supporting the business strategy, IT motivates business strategy in this view. The fourth view is most extremely IT oriented. Here, the business strategy is inferior to the IT strategy. The focus lies on creating a world class IT organization in this view.

2.2 Characteristics of a Legacy System

Describing computer system components is a good first step in comprehending the "whole" and understanding the complexity of legacy systems. Nonetheless, computer systems and legacy computer systems essentially have the same components. That means, the components do not necessarily define an IT system as a legacy system. The definition of a legacy system in literature is overlapping per article. Yet, academia and practitioners seem to have a different opinion on what defines a legacy system. While academia tend to define legacy systems by the many problems they cause, practitioners still emphasize these systems as vital to the organization (Khadka et al., 2014). As a result a broad range of legacy system characteristics can be found, but there is little agreement on a generally accepted definition. In order to summarize the characteristics of legacy systems the technical problems and business issues that legacy systems cause their organizations are discussed.

2.2.1 Technical Problems

Legacy systems resist modification and evolution (Seacord, 2003). Brodie (1992) identifies brittleness; the fear that a legacy system will break, either during modification or unexpectedly, beyond repair. Legacy systems were not designed to cooperate with any other system, i.e. isolation (Brodie, 1992). In addition, legacy systems are often inflexible due to high complexity. The size of the system, the ”spaghetti code”, and the interdependence between the system, its various parts and its environment are just several aspects that make these systems complex (Kaur, Ahamad, & Verma, 2015). Many legacy systems have evolved to massive systems over time with small amounts of functionality being added over and over (Brodie, 1992). Years of changes and modifications to the code cause the code to become coiled and adhering to no standards (Kaur et al., 2015). Stevenson and Pols (2004) indicate that often large amounts of code in legacy applications are unused or irrelevant.

Knowledge about legacy systems is lacking. System experts are retiring while new talent never learned about the system; the amount of suppliers and vendors is shrinking; and documentation is unavailable or half-done at best (Kaur et al., 2015; Khadka et al., 2014). Source code is commonly the only dependable source of information about the system, which makes system understanding incredibly difficult (Bennett, 1995). Legacy systems were designed during a time when software engineering was not matured yet, i.e. there were different constraints at that time such as memory space (Bennett, 1995; Warren & Ransom, 2002). Integration between old and new techniques can be troublesome. Also, the expense to maintain a legacy system can be prohibitively high. Factors that drive up costs are obsolete hardware and software, expired licenses, and a staff or skills scarcity (Khadka et al., 2014; Koedijk & Donkers, 2015). On top of that, maintaining a system may prove ineffective in accommodating necessary changes (Warren & Ransom, 2002).

Technical performance of a legacy system can be an issue too. Randy Mott, former CIO of Wal-Mart, identifies speed as one of the few remaining real competitive advantages organizations can still have in an interview by Nannery (2000). Time of computation is usually higher in legacy systems (Kaur et al., 2015). Kaur et al. also talk about software decay; a general phenomenon where the quality of software deteriorates over time, making it error prone. Stevenson and Pols (2004) state that in order to rewrite legacy code in a modern language, you essentially also rewrite the bugs in the legacy code. This shows that errors and bugs exist in legacy code. The older the operating system – or really any support software – in a legacy system, the more susceptible to attacks the system becomes (Kaur et al., 2015). This translates itself to increased security issues (Khadka et al., 2014). Khadka et al.’ study (2014) shows a mixed opinion on whether or not language determines if a system is a legacy system. Those who agree identify the top five languages in legacy as COBOL, Assembler, PL/I, Visual Basic, and RPG. Bennett (1995) talks about first, second and early versions of third generation languages as legacy.

2.2.2 Business Issues

A major issue with legacy systems is that they are rigid and inflexible; complying with rapid change, evolving technologies and market demands is challenging with these systems (Khadka et al., 2014). As a result legacy systems are limiting a company to grow and innovate (Koedijk & Donkers, 2015). Khadka et al. (2014) say whether a system is legacy or not depends on whether the system is still aligned with the business. Bisbal et al. (1999) recognize insufficient knowledge of the internal workings of a system as a business issue too. The system may be the only place an organization’s business rules exist (Bennett, 1995) and might show years of accumulative knowledge and experience which is not registered elsewhere (Kaur et al., 2015). Due to security flaws and errors the reliability of a legacy system is unavoidably reduced (Kaur et al., 2015; Khadka et al., 2014). This increases unpredictability and risk of failure as knowing what will happen becomes increasing more difficult. Khadka et al. (2014) touch upon the fear shared by most practitioners that eventually the legacy system might fail, even if it is currently working correctly and has been for years.

Probably the main business issue with legacy systems is the paradoxical problem in which organizations should, but are reluctant to replace legacy systems due to cost and risk of failure with such a project. ”*Why fix it if it ain't broke*” is an often used expression in legacy system literature. Legacy systems often contribute a significant amount of economic value (Kaur et al., 2015; Khadka et al., 2014), and perform business critical operations (Bisbal et al., 1999). System replacement usually entails building a new system with the same functionalities (Seacord, 2003; Adolph, 1996). Legacy systems still perform effectively in helping users to achieve their goals, users trust the system and are generally satisfied; and the system covers at least the context that was specified functionality wise, and sometimes even beyond that (the International Organization for Standardization & the International Electrotechnical Commission [ISO/IEC], 2011).

There are no clear guidelines found in current literature that help organizations determine exactly when a system can be regarded as a legacy system. As a result organizations tend to miss that crucial moment to undertake action, even to the point where they find themselves in an outright end-of-life situation as Tromp and Hoffman (2003) noticed in their legacy system case study. ”*One day cost and inconvenience of maintaining a legacy system will tip the balance in favor of an upgrade. The trick is to know when that time has arrived”* (Lamb, 2008).

Due to the many technical problems and business issues associated with legacy systems, the term legacy tends to have a negative association in literature (Lamb, 2008). ”*If you see or hear the term legacy used in reference to software, code, an application, or a device, you can be sure the usage is pejorative*” (Johnson, 2016). To sum up the previous two paragraphs, the characteristics of legacy systems detected in literature are grouped and presented in the table in Appendix 2 according to authors that mention the characteristics.

2.3 Four Perspectives on Legacy Systems

There are different perspectives to be found within the broad definition of a legacy system. Four distinct perspectives are proposed by Alderson and Shah (1999).

2.3.1 Developmental Perspective

The first perspective is the developmental perspective. In this perspective any system that has left development is straight away defined as a legacy system (Alderson & Shah, 1999). That is, any system that is in operation. This view is based on the essence of the word legacy itself; something from the past or something that is handed down from a predecessor to a successor according to the Free Dictionary. Koedijk and Donkers (2015) take on a development perspective stating that a new IT system is directly added to an organization's legacy as a successor needs to maintain it. ”Maintain” and ”successor” are key here. Those who take on a developmental view emphasize that any system needs to be actively maintained due to changes (Alderson & Shah, 1999). As a system ages extraordinary adaptive maintenance where extensive changes are made, while still preserving a significant portion of the system, becomes increasingly more common. But even systems that are fresh out of development need ordinary reactive and preventive maintenance where small changes are made to the system. (Seacord, 2003; Cimitile, Fasolino & Lanubile, 2001)

More often than not, those who develop a system are not the ones that maintain the system; at least not for the complete lifetime of the system. The successor is the person or team responsible for maintaining the system that did not develop the system. The perspective thereby recognizes the need to transfer information and skills from predecessor to successor to maintain the system (Alderson & Shah, 1999). Some might argue this perspective is too straightforward. How to avoid developing new legacy systems if today's solutions are tomorrow's problems (Seacord, 2003). Especially those who perceive legacy as negative or problematic are expected to argue against such a perspective. A system is never intended as a legacy system when it is build. It is discouraging to think that the successful systems being developed today are immediately turned into tomorrow's legacy (Bennett, 1995).

2.3.2 Operational Perspective

The dynamic environment organizations operate in today places speed and efficiency demands on IT systems. In the operational perspective systems that have an older operating system that cannot meet such demands can be considered legacy systems (Alderson & Shah, 1999). Adolph (1996), for example, talks about a limited processing capacity because of dated hardware in the legacy system he was assigned to replace. According to Brodie (1992) legacy software typically uses a legacy database management system (DBMS), such as the hierarchical DBMS. That a system is old can just be considered ageism, but legacy indicates systems that use technology that is considered obsolete compared to more modern standards (Alderson & Shah, 1999; Plotkin, Roy, Snyder, & Stephens, 2014).

Technology in legacy systems is often obsolete because these systems were designed in a different environment with less advanced software engineering techniques (Kaur et al., 2015; Tromp & Hoffman, 2003; Warren & Ransom, 2002). Despite modification efforts, obsolete operating systems still support many applications in information sensitive industries such as the banking sector. Obsolete operating systems might survive because risk and cost trumps the benefits of replacement for many, but they do have trouble keeping up with capabilities of more modern operating systems (Lamb, 2008; Plotkin et al., 2014). This perspective relates well to the technical problems associated with legacy systems. Alderson and Shah (1999) themselves touch upon technical problems such as poor interoperability and compromised security.

2.3.3 Organizational Perspective

The organizational perspective revolves around real-time responsiveness of computer systems towards organizational change. Business processes change to comply for instance with new requirements, evolving technologies, and user demands (Koedijk & Donkers, 2015). Business rules that constrain business processes are adjusted in response to changed legislation and laws too. Because business rules and processes are components of the computer system, the system naturally has to change when rules or processes are adjusted. If organizational change is however hampered by supporting systems' complexity and inflexibility towards change, then these systems are legacy systems (Alderson & Shah, 1999). Lamb (2008) agrees by saying that as long as the system is still serving the business there is nothing wrong with a system being old.

The fact that systems are considered to have a supporting role highlights an important aspect of this view. Legacy systems are seen as vital to organizations because they support critical business processes and functions (Alderson & Shah, 1999). As mentioned, practitioners often see legacy systems as the mainstay of organizations. Should the system fail unexpectedly the impact on an organization is expected to be large (Khadka et al., 2014). Often heard terms in relation to legacy systems are vital, core, critical, and backbone (Bennett, 1995; Bisbal et al., 1999). The organizational perspective reflects well the business issues associated with legacy systems. It sees legacy systems as unfit to support the business, now or in the future, which creates issues.

2.3.4 Strategic Perspective

The strategic perspective weighs the cost of maintaining the system against the financial benefit the system contributes to the organization, and defines an IT system as a legacy system when costs exceed benefits (Alderson & Shah, 1999). Taking into account that the functionality of the system remains unchanged, it is not easy to justify a migration project. Management must be convinced that the organization is really going to achieve a significant benefit in reduced costs and added value (Sneed, 1995). Bisbal et al. (1999) state that as long as maintenance costs are reasonable the system is not exactly a legacy system. Here, designating legacy status is a decision based on a cost-benefit analysis. The strategic perspective therefore relates well to the legacy system paradox where risks, costs and benefits are recognized both in maintaining the system and in replacing it. In addition to the direct financial benefit, this view takes into account opportunity costs, i.e. the cost of opportunities lost when a legacy system cannot support a desired business opportunity, thereby preventing an organization to earn from that business opportunity. By operating legacy systems business opportunities are lost (Bennett, 1995).

2.4 Future-Oriented Perspective

Next to the four perspectives identified by Alderson and Shah (1999), literature touches upon a view focused on the future. Besides Koedijk and Donkers' whitepaper (2015), there is other literature that mentions similar thoughts. Kaur et al. (2015), for example, mention that legacy systems tend to diverge from corporate strategy. Ransom, Sommerville and Warren (1998) state that from a business perspective, the business goals must be understood as they motivate system evolution. System evolution cannot be performed without management understanding. In system evolution management must therefore be motivated to understand IT systems in relation to potential opportunities, and the road to an improved IT environment (Weiderman, Bergey, Smith, & Tilly, 1997). In a CSC white paper it is stated that "*the insurance industry is built upon predicting the future. Every day, carriers calculate premiums based on probabilities of future events. But there is one thing that carriers are not always successful at predicting – the course of future technology ... carriers should look for a vendor that is innovative enough to keep them on a long-term trajectory*" (CSC, n.d., p. 1-2). Ulrich (2000) stresses that an organization must interface, integrate, modernize or even retire its systems before they start to hinder the business strategy; otherwise business opportunities will be lost (Bennett, 1995; Alderson & Shah, 1999). In Appendix 2 an overview is provided of authors that touch upon the future with regard to the legacy systems (see Table Appendix 2 – supporting future needs/goals).

2.4.1 Initial Key Concept of a Future-Oriented Perspective

Based on the recurring observation in literature that a focus on the future with regard to legacy systems is important, the conclusion is derived that a distinct future-oriented perspective will be a significant addition to the existing perspectives on legacy systems. What a future-oriented perspective would entail, however, is unclear. Each perspective described by Alderson and Shah (1999) entails its own key concept of what a legacy system is:

- **developmental view**: any system in production
- **operational view**: any system that runs on obsolete technologies
- **organizational view**: any system that does not support current business operations
- **strategic view**: any system of which the costs exceed the financial benefits it produces

The key concept of a future-oriented perspective on legacy systems is missing mainly because Alderson and Shah (1999) omitted to describe a distinctive future-oriented perspective. Looking at the Strategic Alignment Model by Henderson and Venkatraman, IT can support the business strategy both by supporting current operations and creating future business opportunities. The concept of IT supporting or creating future business needs, goals and opportunities is not taken into account by Alderson and Shah. A potential key concept of a future-oriented perspective on legacy systems can thus be derived from the Strategic Alignment Model: any system that is limiting an organization to grow and innovate is a legacy system.

2.5 Initial Framework to Designate Legacy Status

It can be argued that many characteristics of a legacy system are not per se unique for legacy systems. Most characteristics are attributes of regular systems too. Old age, massive size, complex, interdependent, and vital are amongst others characteristics that are mentioned in literature in relation to regular systems too. Two characteristics are identified as properties of legacy systems, i.e. considered to be truly unique for legacy systems. The research takes the position that, in relation to a future-oriented perspective, a legacy system is a system that is unaligned with the business and inflexible towards change. Reformulating them as general properties of IT systems, the first property is flexibility towards change and the second business alignment. These two properties are regarded to be the characteristics of a computer system fundamental for determining whether a system can be regarded as a legacy system. A causal relationship is detected between the properties and the remaining identified characteristics that are found not to be unique for legacy systems, but rather factors that influence the properties. These characteristics are grouped into a set of factors that are structured under the property they are assumed to influence. The properties and their factors are explained in more detail in the coming two paragraphs.

2.5.1 Flexibility Towards Change

Flexibility towards change means that an IT system supports the business strategy by means of having the ability to respond to necessary changes. That a system needs to change is not surprising considering the dynamic environments that IT systems support. The organizational perspective touches upon system change from a business perspective. Business processes and rules change, and hence, the system that embeds these rules and supports these processes has to change in order to stay aligned with the business strategy. The developmental view stresses system change from a more technical viewpoint. Any system needs to be maintained, and maintenance changes the system step by step. Lehman's laws of software evolution highlight the need of change too (Lehman et al., 1997). The first law states that a system must be continually adapted or it becomes progressively less satisfactory. The second law states that as a system evolves, its complexity increases unless work is actively done to maintain or reduce complexity. Flexibility towards change relates to the proposed future-oriented perspective with as key concept limiting an organization to grow an innovate. If the system cannot continue to support current operations or future business opportunities in support of the business strategy, it is considered inflexible towards change and thereby limiting an organization to grow or innovate.

Based on extensive evidence found in literature that IT systems require the ability to change, the conclusion is derived that the level of flexibility towards change plays a fundamental role in determining when legacy status can be designated to an IT system. The more inflexible towards change a system is, the more plausible it is to regard it as an end-of-life system. The factors that are expected to lower a system's flexibility towards change are explained in Table 1.

Table 1 - Factors expected to influence Flexibility Towards Change

Insufficient Documentation	documentation that is half-done or completely missing, making system understanding difficult
Troublesome Integration	between old and new technologies due to e.g. lacking glue code, resulting in isolation of the system from the rest of the environment
Poor Design	such as in system architecture, infrastructure and other such structures
Spaghetti Code	code adhering to little or no standard that is difficult to understand and almost impossible to unravel
Expired License	Meaning the end of support from a vendor, e.g. Windows XP
Limited Amount of Vendors/Suppliers	that offer support for the system and have knowledge about the system
Massive Size	of the system in code, functionality, interfaces, inputs, outputs, users, etc.
High Interdependence	between the system, its modules or parts and its environment
Embedded Business Logic/Knowledge	the system stores years of accumulative knowledge not documented elsewhere
Shortage of Skilled Staff	to hand down knowledge or support and maintain the system

2.5.2 Business Alignment

Being flexible towards change ensures a system remains aligned with the business. The property business alignment consist of two aspects according to the Strategic Alignment Model. The first aspect is supporting the business strategy by means of being aligned with current business operations. According to the organizational perspective a system should ideally be supporting current business processes and rules. In addition, the strategic perspective highlights the need for systems to deliver economic value. The second aspect is IT alignment with future business opportunities to the extent that IT can modify or even motivate the business strategy. That means preferably organizations have a clear view of the future of their IT environments in relation to upcoming mid- and long-term strategic needs, goals and business opportunities.

The property business alignment relates to the future-oriented perspective as well. If a legacy system is a system that is limiting an organization to grow and innovate in the future-oriented perspective, a property of legacy systems is that such systems are unaligned with the business strategy. A comprehensive amount of literature provides evidence that an IT system should be supporting current business operations in support of the business strategy (see Appendix 2). It is less evidenced whether practitioners should take into account what the future holds for their organizations in relation to their IT environment. Although the property of business alignment can be accepted based on extensive evidence found in literature, the aspect of supporting future needs and opportunities directly relates to a future-oriented perspective on legacy systems, which is yet to be further investigated and verified. The factors that are expected to ensure a system is aligned with the business are displayed in Table 2.

Table 2 - Factors expected to influence Business Alignment

Supporting Critical Operations	those operations that are vital or core for the existence of the organization
Contribute Economic Value	revenue, return on investment, and other benefits.
Satisfying Users	users trust the system and know how to work with it
Storing Vital Information	Information or data that is critical or core to the organization
Efficient Performance	high technical performance, responsiveness, low processing time, etc.
Context Coverage	Functionality; that what a system is able to do. Coverage within and beyond specified context
Performing Reliably	performing with a low risk of failure, low amount of bugs and errors, being predictable and dependable, etc.
Being Secure	being insusceptible to attacks, having security patches available, etc.
Being Compliant	with rules and regulations

2.5.3 Conceptual Framework

In conclusion of the theoretical framework, the just explained concepts that the research will adopt as constructs for further investigation are summarized in the conceptual framework in Figure 4. That is, any system of which the properties are high is considered a regular IT system, and any system of which the properties are low is regarded a legacy system. The conceptual framework forms the basis for further research in this study.

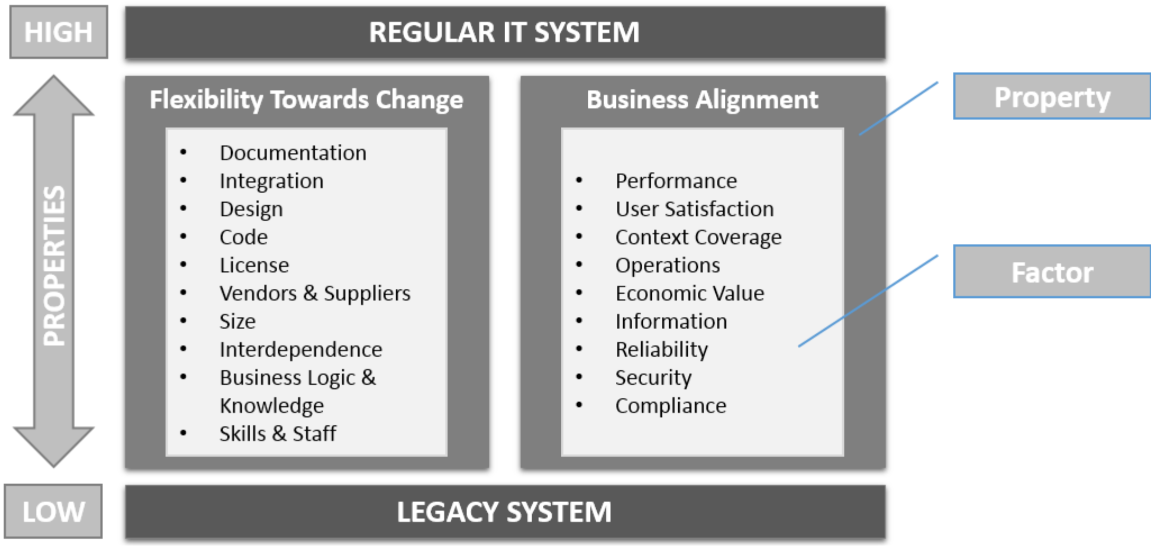

Figure 4 - Conceptual Framework

As part of the conceptual framework the research adopts the working hypothesis (WH) below:

WH1: *"Any system that is limiting an organization to grow and innovate is a legacy system"*

Further research in this study concerns the verification of the working hypothesis and conceptual framework. With regard to the conceptual framework there is a large difference between alignment where IT systems should merely support current operations, or take into account future business needs and goals as well. Because supporting future needs and goals is regarded inferior to supporting current business operations in literature, effort is put into verifying whether it is feasible and necessary to align a system with future business opportunities, needs, and goals. Aligning an IT system with the business by means of supporting future business opportunities relates directly to the key concept that systems should allow an organization to grow and innovate. Verifying the key concept of the potential future-oriented perspective on legacy systems therefore goes a long way in verifying a framework with as property IT alignment with future business needs and goals in addition to current operations.

According to the Strategic Alignment Model, supporting current operations and supporting future business needs are two sides of the same coin; business and IT alignment. Yet, accepting the working hypothesis will mean the two will be separated in different perspectives. It will only be considered worthwhile to split the two aspects in distinctive perspectives if the key concept of a future-oriented perspective is found significant based on empirical data. Should the hypothesis be rejected a future-oriented perspective on legacy systems will be discarded and the framework to designate legacy status will revolve around the flexibility of IT systems towards change to keep supporting current operations in order to stay aligned with the business strategy. The properties flexibility towards change and business alignment with current operations do not require comprehensive verification as they are well evidenced by literature. Nuance lies in whether business alignment entails merely supporting current operations or future business needs and goals as well.

An extensive amount of literature lists the factors that are expected to influence the properties of flexibility towards change and business alignment, even though literature does not explicitly mention such a causal relationship. The significance that each factor has in influencing their designated property is unclear and will therefore be explored. Effort is also put into enhancing the conceptual framework with additional factors, if any can be detected in empirical data.

3 Methodology

This chapter will outline how the research is conducted and acquaints the reader with the motivation for the chosen methods. The quality of the research and ethical responsibility are discussed in the latter paragraphs of this chapter.

3.1 Philosophy

A philosophical perspective serves as the foundation for the design of the research. The philosophical stance of this research is pragmatic. Pragmatists stress that the research question is the determining factor in selecting techniques and procedures (Saunders, Lewis, & Thornhill, 2009), thereby acknowledging that there is no such thing as a “better” approach (Tashakkori & Teddlie, 1998). This allows for a hybrid approach in methods and techniques so long as the end justifies the means. Each philosophy can be elucidated according to the three research paradigms ontology, epistemology, and axiology as explained by Saunders et al. (2009).

Ontology reflects how reality is perceived. Because legacy systems are socio-technical systems the researcher acknowledges that the complex reality of what a legacy system is, and when an IT system can be regarded as a legacy system, is socially constructed, may change over time, and multiple perspectives are acceptable. Epistemology regards what is considered to be legitimate knowledge. This study accepts both observable facts and subjective meanings as legitimate knowledge in performing this research. Axiology concerns the role that values play in a research study. This research is undertaken in a value-free way while the researcher maintains an objective stance because she is neither part of the topic under study, e.g. by means of work activities, nor biased by a previous perspective, e.g. through previous knowledge or experience. Thereby, the researcher remains independent of the data collected.

A research rarely falls neatly into only one philosophical domain. Pragmatism allows for a variation in philosophy in ontology, epistemology and axiology (Saunders et al., 2009). The researcher acknowledges that this study leans more towards interpretivism in ontology, is purely pragmatic in epistemology, while adopting positivism in axiology.

3.2 Research Approach

The theory of inference indicates the form of reasoning used in the research. The theories of inference are distinguished by what the researcher is trying to infer: a result, a rule or a case. The theory of inference corresponding well to pragmatic research is abduction with which a case is inferred from a rule and a result (Lipscomb, 2012; Svennevig, 2001). To see how abduction applies to this particular study, consider the example of a rule, result and case relation below:

Rule: all legacy systems have characteristics A till Z
Result: this system has characteristics A till Z
Case: this system is a legacy system

To explain why abduction works well for this particular research, consider the process of abduction illustrated in Figure 5 and the explanation on the next page.

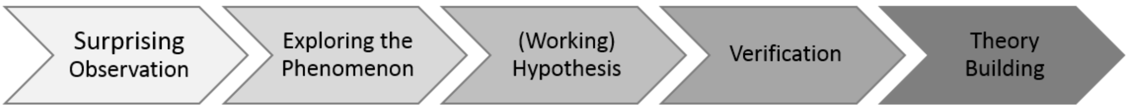

Figure 5- Process of Abduction (Reichertz, 2004)

Abduction is a pragmatic mode of reasoning that includes both logical inference and an innovative character. Abduction starts with a surprising observation which will be explored. An hypothesis is formulated that could be the possible explanation to the observation. That is, a theory is proposed, which gives abductions its innovative character. Empirical data is then collected to verify the hypothesis. The proposed theory will thus be accepted or rejected through reasoning from evidence or facts, i.e. logical inference. (Reichertz, 2004; Lipscomb, 2012)

Observation – the research is based on two (to the researcher) surprising observations:

- There is disagreement on what a legacy system is where different views are acceptable, but a focus on the future with regard to the legacy system definition is lacking
- Organizations find their IT systems to be end-of-life systems because they do not respond in time while they miss the right moment to designate legacy status to a system

Exploration – the study initially set out to explore these observations by means of a literature review. A benefit of abduction is that literature is used both to guide the research direction, associated with deduction, and to provide evidence for assumptions made and conclusions drawn, associated with induction, in order to create a strong link between this study and previous research (Soiferman, 2010). Extensive literature on a definition of legacy systems including legacy system characteristics is available, but two knowledge gaps become apparent:

- a future-oriented perspective would be a significant enhancement to the existing perspectives, but the key concept of such a perspective is unclear
- There is no tool available that can help designate the legacy status to IT systems at the right moment

Hypothesis – literature provides comprehensive evidence for the initial assumption that a future focus with regard to legacy systems is significant. In relation to a future-oriented perspective, the conclusion can be drawn additionally that a legacy system is typically unaligned with the business and inflexible towards change. These conclusions are formulated into a conceptual framework with working hypothesis as presented in the previous chapter.

A conceptual framework is a visual product that highlights the constructs to be further investigated or studied and the relationship between them (Maxwell, 2005; Tidwell, 2007). The conceptual framework shows the researcher her beliefs or ideas on how the phenomena will have to be explored, which is derived from the theoretical framework which shows a much broader scale of ideas and theories (Maxwell, 2005; Regoniel, 2010). The conceptual framework forms the basis for a tool to designate legacy status to IT systems.

To investigate the lacking key concept of a future-oriented perspective, a possible key concept of a future-oriented perspective is derived from literature and proposed in the form of a working hypothesis. A working hypothesis is useful when insufficient data is found to provide a valid answer to the research questions. It is working as an answer for now, but could change as work progresses and more data is discovered.

Verification – the working hypothesis is verified by means of a survey held amongst practitioners and academia in the field of legacy systems. The questions in the survey are in line with the theoretical and conceptual framework, again creating a link between that what is known and that what unknown.

Theory Building – through verification the working hypothesis is either rejected or accepted. The benefit of a working hypothesis is that it allows to be adapted. The working hypothesis will not be rejected so much as it will be adjusted to a new hypothesis to guide further investigation. With abduction new and valid knowledge is thus created in a logical and replicable manner.

3.3 Research Design

Research design is explained according to the concepts of the nature of the research, the research method, the research strategy and the time horizon for the research.

3.3.1 Nature of the Research

The way questions are asked translates into either a descriptive, exploratory or explanatory nature (Saunders et al., 2009). "what is" questions are best answered in a descriptive or exploratory research (de Vaus & de Vaus, 2005). The theoretical framework serves to denote the relevant theories and models, which relates to a descriptive study. Descriptive studies are commonly used to form the foundation to an exploratory or explanatory research (Saunders et al., 2009). The goal of abduction is to explore and produce a valid new theory. An exploratory study is valuable when not enough is known to make an explanatory relationship, as is the case with this research. An advantage of exploratory research is that allows for changes due to newly discovered data at any point during the research process (Saunders et al., 2009), as can be the case with abductive reasoning where a new theory is proposed with a working hypothesis rather than a hypothesis. The nature of the research is thus a combination of descriptive and exploratory research: descripto-exploratory. It should be noted that there is a facet of explanatory research to be found in this study, as a relationship between factors and properties is detected. Yet, as such a relationship is proposed by the researcher rather than evidenced in literature, the purpose is to explore such a relationship rather than rigorously test it.

3.3.2 Research Method

An exploratory research nature suggest this study to be a qualitative research, as quantitative research is often associated with explanatory research. Common for pragmatic research however, it should be noted that facets of quantitative research can be found in the research design.

A primary way of conducting exploratory research is by reviewing literature (Saunders et al., 2009). In qualitative research literature is not extensive enough to make an explanatory relationship between variables (The University of Arkansas, 2016), as is just explained in nature of the research. Creswell (2013) lists natural setting, multiple sources of data, focus on the meaning participants hold, an emergent design where changes may occur at any point during the research process and a holistic account that involves sketching a larger picture including the complex whole of a problem or issue as components of qualitative research that all apply to this research. The use of a hypothesis is common in explanatory quantitative research, but the working hypothesis is tentative and merely proposed as a possible answer instead of a law like truth.

Uncommon for qualitative research is the use of a survey (see data collection) which is structured and allows for a large sample. Nonetheless, the survey yields only nominal and ordinal data which are considered to be qualitative data. On some occasions survey data is quantified, e.g. the Likert Scales do not only show the mode but also the mean and standard deviation through assigning numeric values to non-numeric categories. More advanced statistics, however, are not employed. In addition, the empirical data will be analyzed with exploratory data analysis techniques (see data analysis), which is as the name implies exploratory rather than explanatory. A large part of data analysis relates to analyzing the open question in the survey, which requires the researcher to make interpretations. Making interpretations on the meaning of data is associated with qualitative research (Creswell, 2013).

Employed together with quantitative techniques, qualitative research provides a better interpretation of a complex reality and can bring nuance to what the collected data means (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). All that is discussed above result in a mixed-model method where both qualitative and quantitative data collection methods and analysis techniques are employed, more than one data collection method is used, and qualitative data is quantified (Saunders et al., 2009).

3.3.3 Research Strategy

The question that the research strategy answers is how to verify the conceptual framework with working hypothesis in such a manner that a grounded theory will be developed. Mentioned before is that a questionnaire is employed to be able to verify the conceptual framework and working hypothesis in a relatively short amount of time. The greatest use of questionnaires is made within the survey strategy. A survey strategy relates well to a descriptive and exploratory research as it can help to answer all kinds of questions; who, what, where, how, etc. (Saunders et al., 2009; Yin, 2013) A benefit of the survey strategy is that a large amount of empirical data can be collected in a relatively short amount of time at few expense. Because of high structure in surveys, data is standardized and therefore easy to compare. In addition, a survey yields empirical data that is comparatively easy to explain and understand by means of graphs, tables and figures. (Saunders et al., 2009)

3.3.4 Time Horizon

The time frame in which this research is to be conducted naturally motivates a cross-sectional research design. Cross-sectional studies are performed over a relatively short time period (Saunders et al., 2009); in this case in a 4 month period from mid-January till mid-May 2016. Because the time period is short, data is collected from more than one participant simultaneously (Bryman & Bell, 2015). Also the use of different methods, sometime simultaneously, is common in cross-sectional studies (Saunders et al., 2009). In cross-sectional studies the researcher is particularly looking for variation in participants in order to provide valid conclusions, e.g. people, organizations and industries (Bryman & Bell, 2015). Cross-sectional studies typically employ questionnaires because this is a relatively fast method to collect data, even though the researcher is dependent on many participants in order to collect a representative amount of response.

3.4 Data Collection

This research employs a multiple data collection method design consisting of observation, literature review and survey. Multiple methods are preferred in qualitative cross-sectional studies because together they allow for a better evaluation of conclusions through cross verification (Tashakkori & Teddlie, 1998). Both secondary and primary data are collected with these methods. Data collection methods are explained according to whether they yield secondary or primary data, starting with the former.

3.4.1 Literature Review

Secondary data is yielded by means of a literature review. The purpose of the literature review is twofold. First, it is used to explore the surprising observations to see if any answers can be found. This justifies further research and prevents the researcher from reinventing the wheel. Based on detected knowledge gaps, literature guides the research direction by suggesting the further line of inquiry. Literature is thus particularly important to establish a link between this study and previous research. The protocol for the literature review is described in Figure 6.

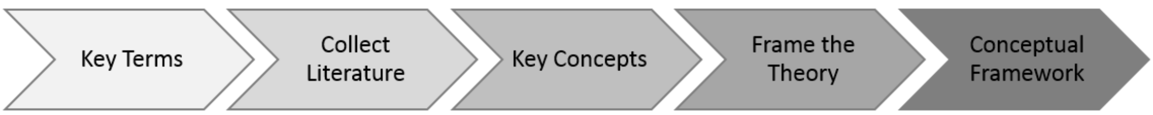

Figure 6 - Literature Review Protocol (Webster & Watson, 2002; Saunders et al., 2009)

3.4.1.1 Sampling

Included literature in the review ranges from academic journal articles and research papers to books, dissertations, online blog and newspaper posts and KPMG whitepapers. Online dictionaries and encyclopedias are used to provide definitions and elaborations on specific terms. The main sources for literature are KPMG's archival records and online academic search portals like Jönköping University Library, Research Gate and Google Scholar. Legacy systems is mainly a technical field. This research, however, has a focus on the business side of legacy systems. This decreases the amount of relevant literature considerably as most is written from a technical perspective. A quick scan of the abstract and conclusion of papers in search of the relevant key terms and concepts indicates whether or not an article is relevant. Key terms used in the search of literature are displayed in Table 3.

Table 3 - Key Terms for Searching Literature

Legacy System Definition	Legacy System Problems	Legacy System Migration
Features Properties Elements Characteristics Understanding	Issues Complexity Paradox	Modification Evolution Reengineering Rationalization System Change

Because literature is limited considerably by relevance there is no restrictive criteria according to publishing date. A trend in legacy system literature is that literature is repetitive. The aim of a literature review is not to summarize existing theory but frame the most relevant and significant theories that support or motivate the research. The theoretical framework is constructed by selecting the most relevant and comprehensive articles and enhancing them with supporting literature, i.e. a consensus strategy is employed. As a general rule articles written in the year 2000 or later are considered more relevant because they represent more up to date knowledge. This rule applies unless an article written before 2000 clearly comprehends or summarizes the main idea better and recent literature supports it. Because literature is repetitive it is important to note that in text referencing is not inclusive. This means that the author deems it unnecessary to reference multiple articles if all make the same point. To review the inclusive list of literature refer to Appendix 2.

The literature review serves to explore the initial observations, meaning observations were initially made. Observation is therefore the first data collection method that yields primary data.

3.4.2 Observation

The initial observations described under the research approach are based on what was observed during the initial period of the internship at KPMG. Delbridge and Kirkpatrick (as cited by Saunders et al., 2009) say observation means immersing oneself in the research context in an attempt to study the world in which the phenomenon occurs. The researcher herself is not immersed in such a manner while she is not working with legacy systems within KPMG. Yet, several colleagues at KPMG do work with legacy systems during projects for clients. The researcher therefore has the opportunity to indirectly make observations based on social actors' experience. This is referred to as "observer as participant" by Saunders et al. (2009) where the researcher does not take part in the activities and her identity and intentions are revealed to all who are concerned. Observations made take the form of experiential data, i.e. data concerning perceptions and experience of social actors where the researcher has written down notes of these perceptions (Saunders et al., 2009). It should be noted that observations are made in a rather unsystematic manner. That means, they occurred while having informal discussions within KPMG, e.g. with the TA partner Joost Koedijk, TA consultants working with such systems and others with an interest in the topic of legacy systems.

3.4.3 Survey

With structuring as a data analysis technique literature is analyzed and a conceptual framework constructed. To verify the conceptual framework the data collection method survey is employed to collect primary data. The survey can be found in Appendix 3. In abduction literature suggests the further lines of inquiry, as explained in Table 4.

Table 4 - Survey Questions in relation to Literature and the Conceptual Framework

Question	Purpose
Q1: are you aware of what a legacy system is?	Segregate potential participants from non-potential participants
Q2: a legacy system is ...?	Verify whether being aligned with future business needs and opportunities is important with regard to legacy systems
Q3: In your opinion, is it important that an IT system is aligned to future needs and goals?	Open question to collect opinion on what a future-oriented perspective would entail, and what the arguments against such a perspective would be
Q4: aligning an IT system with future needs and goals means ...?	Collect opinion on what a future-oriented perspective would entail in a more structured manner
Q5: matrix question	Statements regarding capability and feasibility with regard to IT alignment with future needs and goals
Q6: matrix question	Explore the significance of each identified factor in influencing a system's flexibility towards change. Also sought after factors the researcher missed
Q7: matrix question	Explore the significance of each identified factor in influencing a system's alignment with the business. Also sought after factors the researcher missed
Q8: what is your function or role?	Participant demographics
Q9: in which industry are you active?	Participant demographics

Deriving questions from literature and the conceptual framework is the first step in conducting a survey. The remaining process of the survey strategy is illustrated in Figure 7.

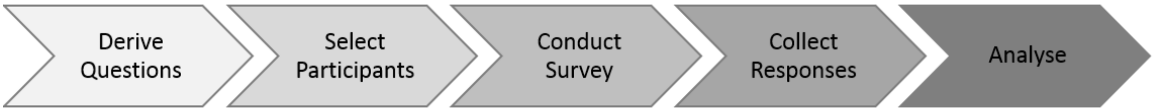

Figure 7 - Questionnaire Protocol (Fink, 2012; Saunders et al., 2009)

3.4.3.1 Sampling

The sampling technique used is non-probability sampling where samples must be selected in some way other than random sampling (Saunders et al., 2009). Data cannot be collected from the entire population, but it must be likely that the sample is representative (Kumar, 2014). Saunders et al. (2009) state there are no rules to determine the size of the sample. The researcher considers a sample between 75 and 100 participants to be representative and realistic.

Having an exploratory research nature makes the sampling techniques self-selection and convenience appropriate. That is, participants are selected based on accessibility to the researcher. Having access to the KPMG network naturally plays a large role in this. But potential participants are sought after in a wider area than just KPMG. The survey invited individuals from a range of industries in the global IT community. This is done through utilizing the researcher' own network, the network of others, searching for relevant people or organizations, writing the authors of articles referenced in the theoretical framework, and promoting the survey on digital channels like LinkedIn and Twitter.

Within cross-sectional studies it is preferred that participants come from different organizations and have different kinds of knowledge about legacy systems. The second sampling technique is snowballing where some of the potential participants are asked to share the survey to those they deem relevant, e.g. when they are working at an interesting organization or have a relevant network. Before the survey was conducted it was tested against KPMG supervisors and verified with the supervisor from JIBS. The survey is conducted through internet, i.e. internet-mediated questionnaire (Saunders et al., 2009). The duration of the questionnaire is approximately 5 minutes and participation is anonymous. Survey results are offered to those that have an interest in it to motivate participation. The survey is open for participation for one month, between April 15th and May 15th 2016, after which the empirical data resulting from the survey are collected, presented and analyzed.

3.5 Data Analysis

Hal Varian, Google's chief economist, states in a video interview with McKinsey & Company that "*the ability to take data – to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it – is … hugely important*" (McKinsey& Company, 2008). The approach towards data analysis employed in this study is called exploratory data analysis. Exploratory data analysis is useful to explore and present data and the connections between data. The technique employs diagrams to understand and examine data. There is a large amount of data presentation methods available to visualize data in exploratory data analysis. Some but not all of the data presentation methods available in exploratory data analysis are relevant for this study. Amongst others, bar charts, tables and pie charts will be employed. The flexibility in exploratory data analysis is beneficial in relation to a working hypothesis that is subject to change when more data is collected and work progresses. Exploratory data analysis starts off with looking at individual variables. Once these are explored and understood, variables are compared to look for relationships. (Saunders et al., 2009)

The open question in the survey requires a different data analysis technique as it presents participants' opinion and experience. A prominent qualitative data analysis strategy is narrative analysis. Within this strategy, structuring is considered an appropriate data analysis technique. Saunders et al. (2009) call this approach narrative structuring. Narrating means giving form to someone's experience in a way that accurately describes participant meaning and is significant by providing insight to the researcher (Bamberg & Cooper, 2012; Saunders et al., 2009). Narrative structuring ensures data is organized with regard to context to create a coherent story from the data collected (Saunders et al., 2009). Structuring meanings through narrative relies much on the researcher' interpretation. It is up to the researcher to create the narrative and make interpretations on what the participant really means.

While the closed questions are presented under empirical findings, the open question is presented under analysis as it involves a large amount of interpretation rather than the mere representation of collected data.

3.6 Research Quality

The quality of qualitative research is often doubted as it cannot be expressed according to the concepts of validity and reliability (Shenton, 2004). The quality of the research is therefore addressed according to the concepts of credibility, dependability, confirmability, and transferability, as proposed by Guba (1981). Credibility addresses the overall trustworthiness of the research. Dependability addresses in qualitative research what reliability would address in quantitative research. Similarly, confirmability is the concept of validity in qualitative research, and transferability the concept of generalizability. Research ethics are briefly discussed as well.

3.6.1 Credibility

Credibility addresses the level of trustworthiness of the research findings from the perspective of the reader and participants (Saunders et al., 2009). Credible research provides findings that correspond with reality (Shenton, 2004).

One way to enable readers to judge the trustworthiness of this paper is through thick description. The researcher' aim is to provide a description in each chapter as complete and in-depth as possible to provide an understandable context to the reader. In addition to thick descriptions, a clear link is made to previous research findings by examining current literature. This ensures the study focuses on current business issues, addresses problems of concern to practitioners, and produces knowledge and tools that are relevant for practitioners. A third tactic is triangulation in methods, participants and sites. The research triangulates in methods by using observation, a literature review, and a survey. The number and diversity of respondents to the questionnaire ensures triangulation in participants; their opinions are extensively verified against each other. The researcher actively seeks after participants from different organizations in different industries, resulting in triangulation in sites as well. Another tactic is the use of well-established methods, i.e. methods that have been successfully implemented in similar research. Khadka et al. (2014) employ a survey strategy to research legacy systems from a business perspective too. Similarly, Kaur et al. (2015) use a literature review to identify the elements of legacy system complexity. Peer evaluation of the research is also an extensively adopted tactic in this study. Peer review is obtained from both supervisors at JIBS and KPMG. Periodic review meetings are held with the assigned supervisor from KPMG every Friday. Intermittently feedback is also provided by the designated supervisor at JIBS.

3.6.2 Dependability

Reliability concerns the extent to which utilized techniques and procedures yield consistent findings. Dependability, in that regard, addresses whether the research is reproducible and if similar findings would be produced by others on a different occasion. (Saunders et al., 2009; Shenton 2004)

To ensure that the study can be reproduced a thick methodological description is provided in chapter 3. The methodological description clarifies why certain approaches are favored while others could have been employed. Chapter 7 also includes acknowledgements of the weaknesses of techniques and methods. The use of overlapping methods increases the likeliness that others would make similar findings. The initial observations made by the researcher, for example, are supported by literature. Readers are able to replicate the study step-by-step via the decisions made and procedures described in this document. Data-oriented diagrams are provided showing protocols and procedures. This is referred to as the audit trail (Shenton, 2004). Thick descriptions clarify thought processes and decisions made, i.e. theoretical audit trail. Saunders et al. (2009) describe two threats to dependability when it comes to data collection techniques: participant error and participant bias. Participant error is prevented as much as possible through sending out the survey at neutral times, i.e. on Tuesday till Thursday mornings. To ensure participants provide honest answers the survey is anonymous, thereby preventing participant bias. In relation to the survey, some other tactics are employed to ensure reliability. Participants with legacy system knowledge are not segregated out based on experience, knowledge, industry or current function. The questionnaire does however include a segregation question that separates those with knowledge of legacy systems from those without this knowledge. This allows for large distribution of the survey. Lastly, a sample size higher than 75 ensures a significant amount of response. In other words, verification is sought in extensive numbers.

3.6.3 Confirmability

Confirmability corresponds to validity, which addresses whether research findings are truly about what they appear to be about. Qualitative research should ensure that findings are the result of participant meaning rather than the preference of the researcher.

With the use of multiple methods and a hybrid approach of qualitative with quantitative methods, it is acceptable to assume that the research will yield valid findings. Saunders et al. (2009) name two potential threats to confirmability as observer error and observer bias. The survey is highly structured, leaving no room for deviance in data collection technique per participant. This lessens observer error. Nonetheless, questionnaires will always be slightly prone to observer error as they are still designed by humans. Observer bias is the most difficult to prevent since especially narrative structuring relies heavily on the interpretation of the researcher. In order to prevent observer bias the survey is built on the concept of iterative questioning.

Iterative questioning is useful to detect inconsistencies in answers. Iterative questioning is done by including several related or rephrased questions on the same topic to cross verify answers and ensure data is actually showing what the researcher thinks it is showing (Saunders et al., 2009; Shenton, 2004). In addition to iterative questioning, the researcher employs a 'check of interpretations' tactic. Due to the large number of respondents in the survey it is deemed impossible to perform participant checks in which each participant is individually asked whether he or she agrees with the interpretation of the researcher. However, any interpretations that the researcher makes are verified on the basis of peer review, and a negative case analysis is performed in order to ensure findings are not the preference of the researcher. In addition, the researcher aims to clearly notify readers on any assumptions that are made. Admission of limitations of the study are another tactic employed to help the reader judge the confirmability of the research. Such limitations are described under the discussion in chapter 7.

3.6.4 Transferability

Transferability is proposed by Guba (1981) instead of generalizability, which addresses whether findings may be equally applicable in other research settings. The purpose of the research is not to produce a theory that is accepted by all and generalizable as a standard definition of legacy systems. The purpose is to enhance the existing perspectives within the definition of a legacy system by means of proposing an new and additional perspective. This is to help construct an as all-encompassing definition on legacy systems as possible.

With that said, it is still valid to argue the research is transferable. A first tactic to ensure transferability is a thick description of the context in which this study is performed. It is acknowledged the study adopts a business perspective rather than a technical perspective. Additionally, the organization for which this research is performed is described, as well as the study of which this research is in continuation. This allows readers to compare the research context with their own context in order to establish the applicability of this study in their own environment. Peer review is employed in the monthly seminars in which fellow graduate students and supervisors opposed this paper. This highlighted inconsistencies, jumps in logic, unclear argumentation, and overall "bad" research early on and continuously during the process of research so that adequate measures could be taken in time. Because participants in the survey come from different industries and perform different functions within their organizations it is acceptable to assume some degree of transferability. Diversity in participants makes findings valid for a larger population. Utilizing a negative case analysis contributes to transferability as well. Negative case analysis is employed in describing a future-oriented perspective and is derived from participants in the survey disagreeing with such a perspective. The weakness in the developed theory is thus acknowledged.

3.6.5 Research Ethics

Pragmatic research assumes that in answering the research questions the end justifies the means. Nonetheless, concerning research ethics a deontological view is taken on in which the end can never justify unethical means (Saunders et al., 2009). This means no unethical method will be employed, even if this method would yield the most valid and reliable findings. This is reflected in a couple of ways. The privacy of participants is respected. Participation in the survey is voluntary, anonymous and participants have the right to withdraw from the survey at any point before submission. In addition, the research is unlikely to affect negatively the well-being of any participant and does not contain any sensitive information.

4 Empirical Findings

In this chapter the empirical data from the conducted survey are presented. The results cover participant demographics, the future-oriented perspective on legacy systems, and the factors that influence the properties of a legacy system in relation to a future-oriented perspective

4.1 Participant Demographics

In total 85 potential participants were triggered to fill in the survey. Of those, 76 participants completed the survey. The remaining 9 participants responded, but were unaware of what a legacy system is. Therefore, they were redirected to the end of the survey after question 1.

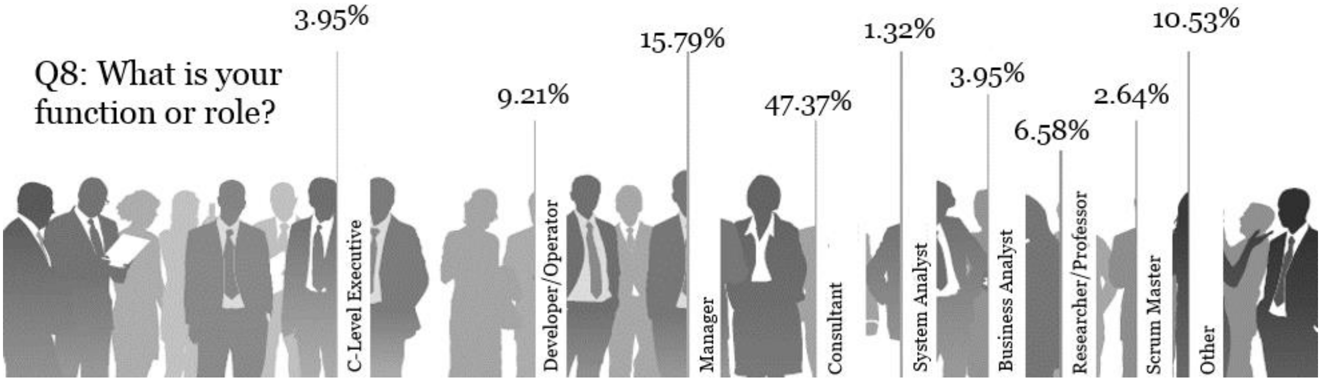

Figure 8 – Survey Respondents

Most respondents identified themselves as consultant. Respondents in the second largest group are developers, operators and managers. A third group includes C-Level executives, business analysts, academia and scrum masters. Others include an information manager, an intern, two graduate students, a managing director, an IT auditor and a project manager.

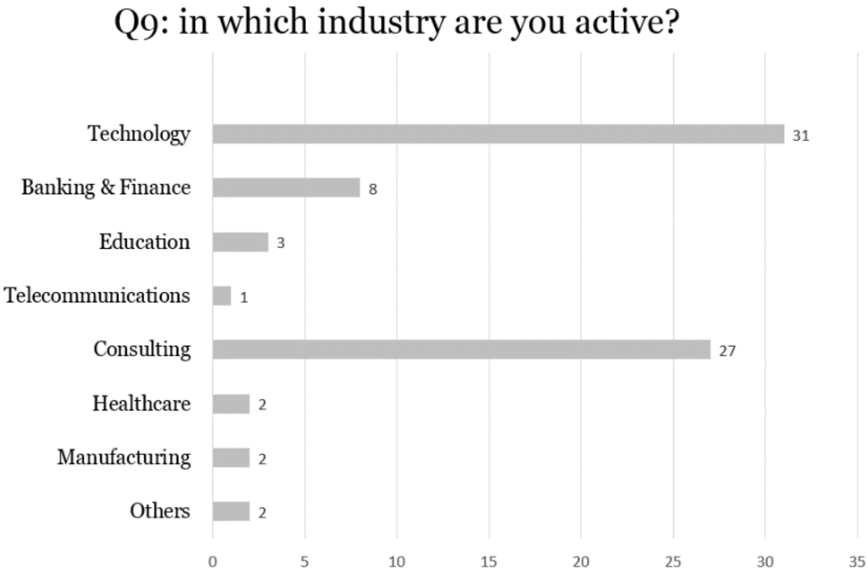

Figure 9 - Respondent Industries

Regarding industry, most participants are active in the technology and consulting industries. Industries such as the public sector, retail, transportation, and insurance were not reached. For others participants identified their industry as business services or several industries at once. Three write-ins were provided for other that relate to technology. These three are redistributed to technology. No significant differences in response were found by filtering on industry or function.

4.2 Future-Oriented Perspective

Based on Alderson and Shah' their article (1999) it is known that at least four perspectives within the legacy system definition are acceptable. To test the significance of the future-oriented perspective question (**Q2**) "*a legacy system is* ...?" is asked. The answer options each represent one of the five perspectives. Participants were allowed to select more than one statement.

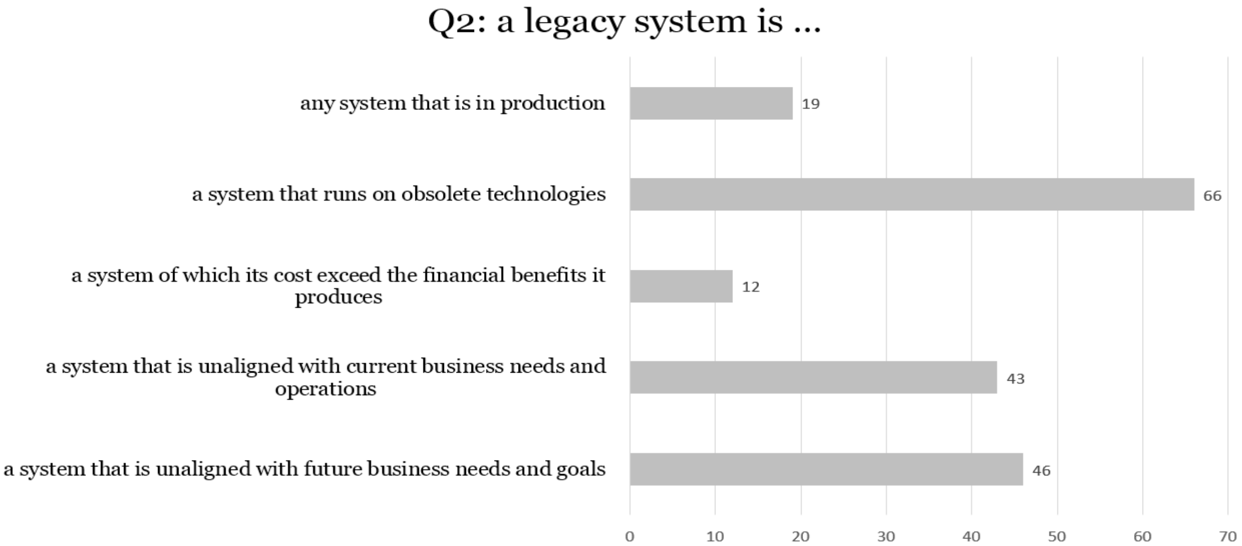

Figure 10 – Selected Perspectives on Legacy Systems

Significance of the future-oriented perspective is based on the percentage of participants that select the statement related to this perspective: "*a system that is unaligned with future business needs and goals*". It is taken into account that people disagree on what a legacy system is. Therefore, Significance of a future-oriented perspective is not based on obtaining 100% agreement with the statement. Of all participants 60.5% agrees that a system that is unaligned with future business needs and goals can be considered a legacy system. Because this represents significantly more than half of the participants, and because the statement is only trumped by the operational perspective with 86.8%, the future-oriented perspective is considered to be significant as a distinctive perspective.

Q5: please rank the following statements	strongly disagree (1)	disagree (2)	neutral (3)	agree (4)	strongly agree (5)	mean	standard deviation
	Σ	Σ	Σ	Σ	Σ	μ	σ
It is feasible to align an IT system with the business strategy	-	3x	6x	36x	31x	4.25	0.77
IT is capable of predicting business needs and goals	6x	25x	25x	19x	1x	2.79	0.96
Business opportunities are lost because of legacy systems	2x	5x	16x	36x	17x	3.80	0.95
It is possible to predict the future of technology	8x	16x	23x	28x	1x	2.97	1.03
Obsolete technology is no problem if a system is performing well	9x	32x	11x	22x	2x	2.68	1.10
Obsolete technology is no problem if a system is aligned to the business strategy	4x	31x	12x	26x	3x	2.91	1.06
The age of a system is insignificant if it is performing well	6x	22x	14x	26x	8x	3.11	1.17
The age of a system is insignificant if it is aligned to the business strategy	4x	14x	12x	39x	7x	3.41	1.06
If a system's costs exceed financial benefits the system is unaligned to the business	2x	26x	12x	23x	13x	3.25	1.18

Figure 11 - Cross-Verification Significance Future-Oriented Perspective

The first thing that comes to mind with the term legacy system is the term old. Yet, looking at the most often selected value, or mode, participants agree that the age of a system is insignificant if it is performing well and aligned to the business strategy. On average, participants are neutral towards these statements, leaning towards agree. Participants also show neutrality when it comes to the cost of a system as an indicator for legacy systems. Obsolete technology seems to be the most relevant indicator in relation to the other perspectives on legacy systems, as indicated in questions 2 as well.

Significance of a future-oriented perspective is cross-verified with statements in question 5 that touch upon the aspects of feasibility and capability (see Figures 11). On average participants lean towards strongly agreeing on that it is feasible to align an IT system with the business strategy, having selected agree and strongly agree most often. Participants are equally neutral and in disagreement with IT groups predicting business needs, while most participants agree it is possible to predict the future of IT. On average participants agree that business opportunities are lost because of legacy systems, which is also the most often selected value for this statement. Altogether, it can be concluded that having a focus on future possibilities is important, but that it is not always easy to predict what is going to happen in the future both business and technology wise.

Looking at question 4 "*aligning an IT system with the business strategy means…?*" it becomes clear that it is most important to ensure a system can change in time to support future needs and goals. This highlights the importance of the property flexibility towards change. Knowing a system can already support future needs and goals is considered less relevant with 36.8%. Having the resources available to change a system in time to support future needs and goals is also considered less relevant (47.7%). Both knowing what the organization's future needs and goals are and ensuring the business strategy takes into account the capabilities of IT score 52.6%, showing more than half of the participants consider this part of aligning an IT system with the business strategy.

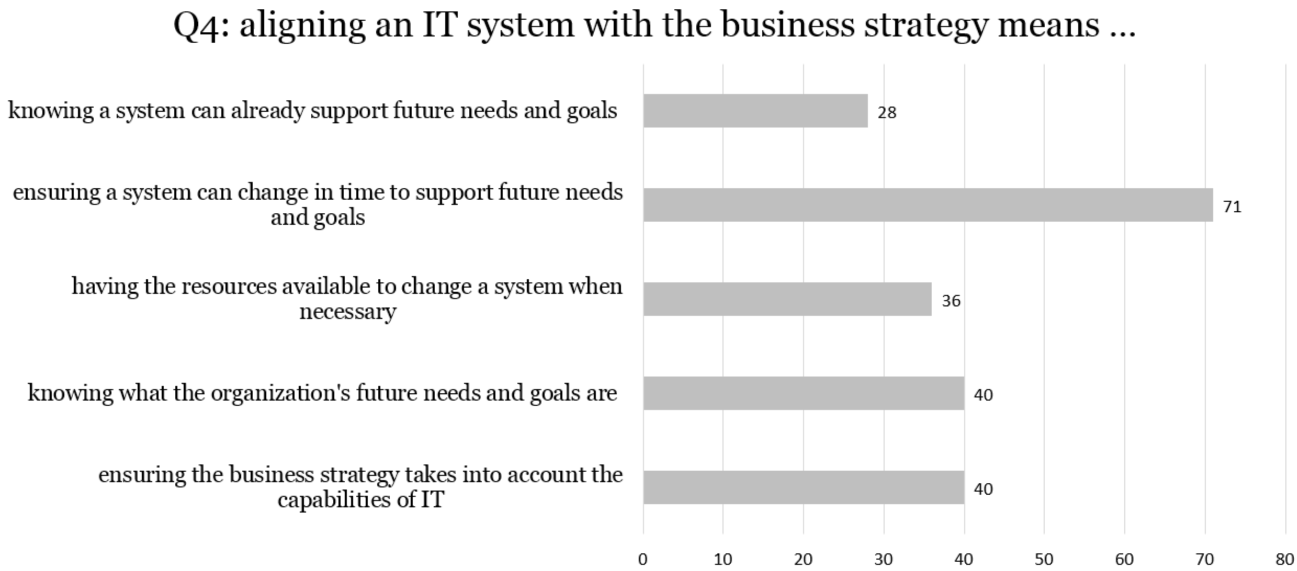

Figure 11 - What does Business & IT alignment mean

4.3 Factors Influencing the Properties

Factors that influence the properties flexibility towards change and business alignment are derived from literature. Whether factors are (1) truly a factor influencing their designated property, (2) whether each factor is significant in influencing the property, and (3) whether any factors are missing is explored according to matrix question 6 and 7 in the survey. Figure 13 and 14 on the next page show the survey results.

Q6: factors flexibility towards change	Very insignificant (1)	insignificant (2)	significant (3)	very significant (4)	not applicable (0)	Mean	Standard deviation
	Σ	Σ	Σ	Σ	Σ	μ	σ
Insufficient Documentation	-	9x	44x	23x	-	3.18	0.63
Isolation	1x	8x	37x	29x	1x	3.25	0.70
Poor Design	1x	4x	32x	35x	4x	3.40	0.66
Spaghetti Code	-	6x	34x	34x	2x	3.38	0.63
Expired License	6x	34x	16x	13x	7x	2.52	0.90
Limited No. of Vendors/ Suppliers	-	24x	31x	12x	9x	2.82	0.72
Massive Size	3x	21x	33x	15x	4x	2.83	0.80
High Interdependence	-	9x	43x	22x	2x	3.18	0.63
Embeds much Business Logic/Knowledge	5x	22x	32x	12x	5x	2.72	0.83
Lack of Skills/Staff	1x	3x	30x	38x	4x	3.46	0.65

Figure 13 - Factors Flexibility Towards Change

Looking at the mode, one factor is considered to be insignificant in influencing a system's flexibility towards change: an expired license. This factor is also least often detected in literature (see Appendix 2). The mode also shows that poor design, spaghetti code and a lack of skilled staff are most significant in making a system inflexible towards change. All others are considered to be significant. After considering all write ins for other, the research assumes one more factor could be significant in exerting influence over the flexibility of a system towards change: the level of standardization. Standardization means implementing IT systems according to standards instead of highly customizing the system. While formulated under others, the significance of this factor is unverified.

Q7: factors business alignment	Very insignificant (1)	insignificant (2)	significant (3)	very significant (4)	not applicable (0)	Mean	Standard deviation
	Σ	Σ	Σ	Σ	Σ	μ	σ
Performs Effective	-	4x	45x	25x	2x	3.28	0.56
Satisfies Users	1x	3x	36x	34x	2x	3.39	0.64
Covers (beyond) Specified Context	-	16x	35x	3x	22x	2.76	0.55
Supports Critical Operations	1x	7x	24x	40x	4x	3.43	0.73
Contributes Economic Value	1x	7x	36x	29x	3x	3.27	0.69
Stores Vital Information	3x	13x	34x	19x	7x	3.00	0.80
Performs Reliably	-	7x	39x	28x	2x	3.28	0.63
Is Secure	-	13x	30x	30x	3x	3.23	0.74
Compliant with Rules & Regulations	-	8x	39x	27x	2x	3.26	0.64

Figure 14 - Factors Business Alignment

Of all factors, covers (beyond) specified context is selected most often not to be applicable. The mode of this factor, however, still shows significance as 13 participant more selected significant. On average the factor is significant. No factor under business alignment was considered to be insignificant based on the mode of selected values. Again, one factor was proposed which this research will assume to be significant. The researcher considered maintenance to be an effect rather than a cause, but maintainability of the system is mentioned several times, e.g. the extent to which tests are available and automated and having the developmental processes in place to maintain a system. Maintainability is therefore reconsidered as a significant factor in influencing alignment of an IT system to the business, although the real significance remains unverified.

5 Analysis

This chapter provides a discussion on the interpretation of the empirical findings. Empirical findings are analyzed according to the literature discussed in the theoretical framework. Where variables have been analyzed individually in the previous chapter, variables are now compared to look for relationships. The first part of this chapter concerns the key concept of a future-oriented perspective, the second part the framework to designate legacy status to IT systems.

5.1 Key Concept of a Future-Oriented Perspective

In response to the open question (**Q3**) ”*In your opinion, is it important that an IT system is aligned to the business strategy (i.e. future business needs and goals)?*” two aspects were mention often by participants: the communication between business and IT groups and IT systems drive business innovation. Note that anonymous participants in the survey are quoted in the next paragraphs.

5.1.1 Communication between business & IT Groups

This aspect touches upon the age old divide between business and IT groups. As one participant puts it ”*among the risks of misalignment are ... mutual dissatisfaction of both IT and business stakeholders with each other due to a lack of common goals and understanding*”. Other participants too support the need of business and IT groups to work closely together towards a common goal. ”*In current business IT does not have a supporting role. Rather, IT and business cooperate and follow the same paths towards business success*”. Many participants talk about the risk of disconnectedness: ”*Among the risks of misalignment are: wasteful usage of IT, sunk costs, difficulty to track true value of IT, poor effectiveness of IT in support of business needs, and slow reaction times of the organization to technological or market shifts in the competitive environment*”. ”*Systems that are not aligned to the business strategy often lead to workarounds and suboptimal solutions*”. ”*If they are unaligned .. IT systems might.. make the business more inefficient*”. Therefore, ”*IT and business should be intertwined and in constant communication*”.

Constant communication is not surprising considering IT systems are socio-technical, as highlighted under the components of a computer system. Looking at question (**Q4**) ”*aligning an IT system with the business strategy means ...*” shows that participants equally agree on the fact that IT groups should know what the organization’s future needs and goals are (53%) as that the business should take the capabilities of IT into account (53%). This relates to how Luftman (2004) describes business and IT alignment: communication, trust, and understanding. ”*It is also possible that the business strategy will have to be adjusted due to the restrictions of the IT systems*”. In other words, both business and IT groups need to be aware of each other. ”*I always think that the CTO should shape strategy through the lens of technology, but the best strategy comes from collaboration*”. Good communication thus leads to mutual understanding and effective collaboration which ensures IT system remain aligned with the business.

5.1.2 IT System Drive Business Innovation

Much literature, including the article by Alderson and Shah (1999), mentions how IT systems are vital or core because they support business critical operations. With regard to IT systems supporting potential future business opportunities, it is mentioned by multiple respondents that IT can be the driving force behind business innovation. ”*It is absolutely crucial to have IT systems aligned to the business strategy, since IT is an enabler for most business needs in a more and more digital environment. IT can also create business opportunities and Unique Selling Points to not only enable but drive the business*”. We live in a much more digital environment now than seventeen years ago when Alderson and Shah studied the different perspectives on legacy systems. It is not surprising that IT driving business innovation was a less relevant concept at the time. At present, however, there are many companies to be found where IT plays a large role in business innovation. ”*IT can ... be a driving force behind innovation, disrupting industries, e.g. Uber versus the traditional taxi*”.

The level of competitive advantage that IT can create varies. ”*It depends on the nature of the business whether IT is a strategic driver or a commodity, e.g. a restaurant only needs a registry and ordering system, but for most large businesses IT is indeed a driving factor to accomplish goals*”. Instead of solely supporting the business strategy, ”*IT systems should impact the business strategy*”. ”*IT has proven itself to be an enabler for the business ... new capabilities allow the business to set new targets and goals. In this view, IT should not only be supporting the business strategy but also be allowed to venture beyond that*”. To summarize ”*IT can be a catalyst or a drag factor*”. When an IT system is rather a drag factor, not allowing new business opportunities to be created, such a system can be regarded as a legacy system.

5.1.3 Arguments Against a Future-Oriented Perspective

As expected, not all participants agree that an IT system should be aligned to future business opportunities. One opposing argument is that ”*it depends on the system in question. If it is business critical yes I believe this is true. But if it is just a utility system it does not matter*”. It can therefore be argued that some systems should not be rationalized or migrated even if they are limiting an organization to respond to business opportunities. ”*An IT system is preferably aligned with future needs, but does not need to. There can be business, financial, political or other reasons to keep a system that is not aligned*”. In other words, ”*If the future business needs require the IT system, then yes*” alignment to the future needs and goals is necessary. Yet another participant sums up several situations where an IT system does not have to be aligned with future business opportunities either. ”*End-of-life systems, systems that are to be rationalized or phased out, system where it will be too costly to align them to the business strategy compared to the gained benefits*” are all such examples.

One participant argues about feasibility. ”*Being aligned with future needs and goals is a ’nice to have’ and for most IT systems not a realistic requirement, considering that future needs and goals are in most cases not specific enough and not fixed. In case the business strategy is fixed and short term, then it becomes important the IT system is aligned*”. Yet, in matrix question (**Q5**) on average participants lean towards strongly agreeing in response to the statement that it is feasible to align an IT system with future needs and goals. What most negative case participants agree on is that organizations should ensure a system can change in time to support future business opportunities. ”*I think it is more important for an IT system to be easy to be adapted to future needs*”. ”*An IT system needs to fulfill the current business needs. A good IT system would also be flexible enough to adapt to the new needs and wants from the business when they become actual, but it should not be the goal of the IT system to develop this before the organization needs it*”. This is supported by survey question (**Q4**) showing that only 42.4% of the participants believe alignment means knowing that a system can already support future business opportunities now. 93.9% agree that alignment means ensuring a system can change in time to support future needs and goals.

5.1.4 Verification of the Working Hypothesis

Take into account that negative case analysis is natural; especially when it is a known fact that disagreement exists between social actors on what a legacy system is. Negative cases can be found in each of the perspectives. Question 2 on what a legacy system is, indicates only 11 participants believe a legacy system is a system of which its cost exceed the financial benefits it produces. Yet, this is the key concept in Alderson and Shah their strategic perspective (1999). Similarly, the same question shows only 15 participants agree that any system in production is a legacy system.

That communication between business and IT groups and IT driving business innovation are mentioned often by respondents provides evidence that any system limiting an organization to grow and innovate can be regarded a legacy system. On that premise, the working hypothesis is accepted. This means a future-oriented perspective on legacy systems is considered significant. In addition, the framework to designate legacy status will incorporate alignment of IT systems with future business opportunities as part of the property business alignment.

5.2 Framework to Designate Legacy Status to IT Systems

Based on the properties and factors of IT systems, the framework in Figure 15 is developed with the purpose to guide practitioners and organizations to designate the legacy status to IT systems.

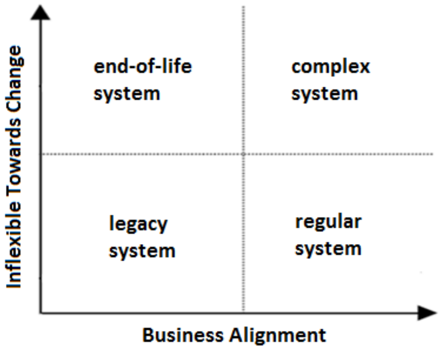

Figure 12 - Framework to Designate Legacy Status to IT

The axes in the framework represent the two properties of legacy systems. The Y-axis corresponds to the property flexibility towards change. At the top of the Y-axis an IT system is considered most inflexible towards change. The X-axis represents the property business alignment, covering IT supporting the current operations as well as future business needs or opportunities. IT alignment with current operations trumps IT alignment with future needs and goals. Where assigning legacy status is to facilitate appropriate response, a system that is unaligned with current operations always requires some kind of response. If a system does not support current business operations it is an irrelevant discussion whether or not to assign the system legacy status. It is not likely that anyone with a system that is unaligned to current business operations and needs would argue that maintaining the status quo is sufficient. Nonetheless, the response towards the legacy system problem could be to align the system with a potential business opportunity. This explains why alignment with business opportunities can be high when alignment with current operations is low. A system can be unaligned with current operations, and hence be regarded as a legacy system, but nonetheless be aligned to an upcoming business opportunity; for example through ensuring the system can change in time to support this opportunity. Tables 5 and 6 illustrate how the framework is to be employed.

Table 5 - Employing the Framework Part I

Business Alignment With		Flexibility Towards Change	Explanation	Type of System
Current Operations	Business Opportunity			
Low	Low	High	- the system does not support current business operations - alignment with future needs/goals is therefore irrelevant - the system is able to change	Legacy system
Low	High	High	- the system does not support current business operations - alignment with future need/goals is therefore irrelevant - the system is able to change	Legacy system
High	High	High	- the system supports current business operations - the system is aligned with future needs and goals - the system is able to change	Regular system
High	Low	High	- the system supports current business operations - the system is unaligned with a potential business opportunity - the system is able to change	Legacy system

Table 6 - *Employing the Framework Part II*

Business Alignment With		Flexibility Towards Change	Explanation	Type of System
Current Operations	**Business Strategy**			
High	High	Low	- the system supports current business operations - the system is aligned with future needs/goals - the system is unable to easily change	Complex system
High	Low	Low	- the system supports current business operations - the system is unaligned with a potential business opportunity - the system is unable to easily change	End-of-life system
Low	Low	Low	- the system does not support current business operations - alignment with future needs/goals is therefore irrelevant - the system is unable to easily change	End-of-life system
Low	High	Low	- the system does not support current business operations - alignment with future needs/goals is therefore irrelevant - the system is unable to easily change	End-of-life system

In relation to a future-oriented perspective, where a legacy system is a system that is limiting an organization to grow and innovate, whether or not a system should be designated the legacy status is derived from the level of alignment of the system with the business. That means, an IT system that is aligned with the business is either a regular or a complex system, based on the level of flexibility towards change. While designating legacy status is to facilitate appropriate response, an end-of-life system indicates a legacy system that cannot change easily because it is complex. Flexibility towards change thus correlates with the level of complexity of a system.

Note that the table is based on extreme cases, e.g. low alignment with current operations in the table indicates no alignment at all. In reality, the situation is often not as black and white. The framework is constructed as a matrix in order to allow for the grey areas. Systems can be mapped anywhere on the grid on the lines of the two axes. Where exactly systems are to be mapped on the grid can be determined according to the factors that influence the two properties. In order to decide how high or low a system's flexibility towards change is, and how well the system is aligned to the business strategy, the factors in Table 7 should be considered.

Table 7 - *Properties and Factors*

Flexibility towards change	Business Alignment
Documentation	Performance
Staff & Skills	User satisfaction
Integration	Functionality
Design	Supported operations
Code	Economic value
Vendors & Suppliers	Stored information
Size	Reliability
Interdependence	Security
standardization	Maintainability
Embedded business logic & knowledge	Compliance with rules & regulations

6 Conclusion

To conclude the paper, an answer is provided to each research question. Focus lies on reflecting on the purpose of the research and summarizing the main findings of this study.

RQ1: What is the key concept of a future-oriented perspective on legacy systems?

The first purpose of the research was to explore a future-oriented perspective on legacy systems. In a future-oriented perspective a legacy system is a system that is limiting an organization to grow and innovate. That is, any IT system restraining the organization from responding to business opportunities or goals can be considered a legacy system. Business alignment can mean more than simply supporting current operations. It is important that systems are able to change in time to support a changing business strategy. But it is also important that IT systems can venture beyond a mere role of support. In that sense, IT's capabilities can even create business opportunities. The level of competitive advantage IT can create varies per organization, but IT systems can sometimes shape the business strategy. Rather than simply supporting the business strategy, IT systems can be the driving force behind business innovation.

Because IT systems are socio-technical, constant communication between business and IT groups is required to ensure business and IT alignment. Both groups are trying to achieve the same goal, i.e. business success. Disconnectedness often results in mutual dissatisfaction and a decrease in business efficiency. 'Socio' and 'technical' play equal roles. It is necessary that IT groups are knowledgeable about the goals that the business is trying to achieve, and the way in which IT can support these goals. It is just as necessary that the business knows the capabilities of IT. Not only to drive business innovation, but also to know the limitations and restrictions of IT. The best overall strategy comes from collaboration. Therefore, IT and business groups should be intertwined and in constant communication.

RQ2: What are the properties of a computer system fundamental for determining whether or not a system can be regarded as a legacy system?

The second research purpose was to develop a framework to designate legacy status to IT systems at the right moment. In relation to a future-oriented perspective on legacy systems, whether or not to designate legacy status to an IT system is best determined according to the system's flexibility towards change and the alignment of the system with current operations and future needs and goals. Based on these two properties a framework is developed to guide practitioners and organizations in designating legacy status to IT systems. A system that is unaligned with current operations or future needs and goals is considered a legacy system. If that system is also inflexible towards change, it can be regarded an end-of-life system. If the system is aligned with the business but very inflexible towards change, it is considered to be a complex IT system. In the best case scenario an IT system is aligned with the business and can respond to changes when necessary. Such systems are considered to be regular IT systems, as opposed to legacy systems.

Designating legacy status with the help of this framework is essentially to acknowledge an IT system is problematic for the organization it supports. Acknowledging the legacy system problem should motivate organizations to undertake appropriate response, preferably before an IT system turns into an end-of-life system. Factors such as documentation, size, interdependence, staff, integration, design, code, vendors, embedded business logic and standardization all influence the flexibility of a system towards change. The operations the system supports, the information the system stores, the economic value, the user satisfaction, and the functionality, performance, reliability, security, compliance, and maintainability of a system all influence the alignment of a system with the business.

7 Discussion

The research set out to explore the key concept of a potential future-oriented perspective on legacy systems. Through the identification and verification of a key concept in relation to a future-oriented perspective the conclusion is derived that such a perspective is significant. By having verified the significance of a future-oriented perspective, and by providing a description of what such a perspective entails, this research contributes to current knowledge on legacy systems. The future-oriented perspective is an enhancement to the four perspectives proposed by Alderson and Shah (1999). The purpose of the research is not to provide an officially accepted standard definition of legacy systems. The researcher acknowledges that multiple different and contradicting perspectives are acceptable. Proposing a future-oriented perspective is to either cause those inside and outside the field of legacy systems to see things differently, or provide them with a more all-encompassing definition of the kind of systems that can be regarded as a legacy system.

In relation to the future-oriented perspective on legacy systems, two properties are considered to be fundamental in determining whether or not a system can be regarded as a legacy system. These properties were derived from the characteristics of a legacy system identified in academic literature. Through organizing the characteristics of a legacy system under properties that define a legacy system and factors that influence the properties of a legacy system, a framework could be developed that can guide practitioners and organizations to designate the legacy status to IT system at the right moment. Thereby, this research has addressed a problem that is relevant in current times and of concern to practitioners. Designating legacy status to IT systems is to facilitate appropriate response. Providing a tool that can be utilized to designate legacy status to IT systems is expected to help prevent those inside the field of legacy system from reaching an end-of-life state with their IT systems.

Even though the research has contributed in the form of knowledge and a tool, there are certain limitations to this study. Research findings become more valid when other research supports it. An in-depth study on the future-oriented perspective is required. For example, the aspect of time in IT alignment with business goals and opportunities is not studied rigorously. One weakness of the survey strategy is that more such features of the future-oriented perspective are most likely undetected. More detailed features need to be established to gain more prominence for a future-oriented perspective. Another weakness in the survey strategy is the difficulty to reach C-level executives that are expected to hold detailed knowledge on such features. In future research it is worthwhile to further explore the future-oriented perspective for example by interviewing C-level executives with holistic knowledge on legacy systems. Despite the acknowledged weaknesses, the researcher deemed it more appropriate to employ a survey strategy in this research because disagreement exist on what a legacy system is. Interviewing C-level executives about a future-oriented perspective while detailed features of such a perspective are not identified yet is expected to result in a pointless discussion on what a legacy system is rather than an in-depth discussion on a potential future-oriented perspective.

Another limitation to this study is that the proposed framework is not tested in practice. Putting the framework into practice will be worthwhile for future research as well. A multiple case study research could be performed where regular systems, systems expected to be legacy systems, and legacy systems are tested according to the framework with its factors. This should establish whether the proposed framework holds in practice. In addition, an explanatory relationship is proposed between properties and factors. This causal relationship should in future research be tested with more rigor where it has merely been explored in this research.

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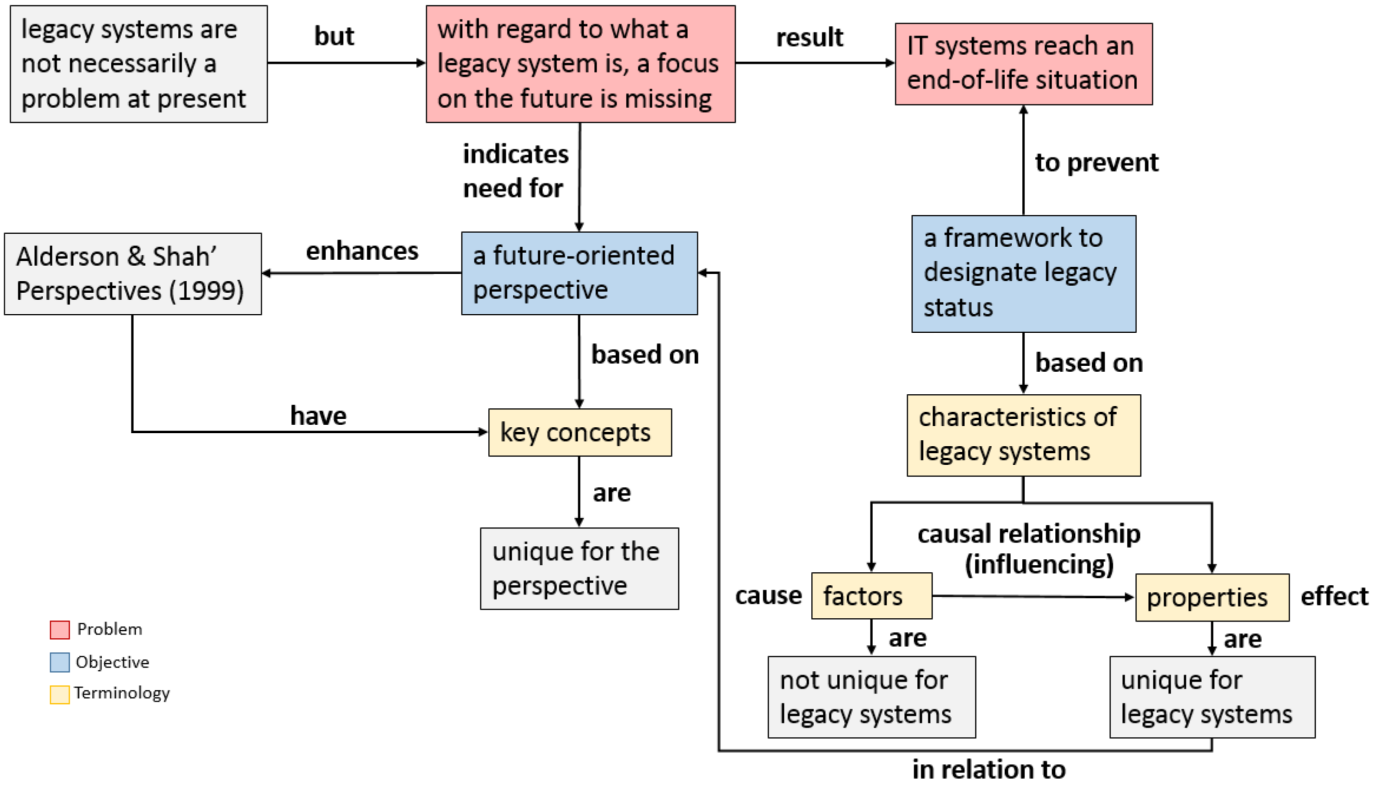
Appendix 1 – Overview Introduction



Appendix 2 – Literature Review

	documentation	Integration	Design	Code	License	Vendors & Suppliers	Size	Interdependence	Business logic & knowledge	Staff & skills	Performance	User Satisfaction	Context Coverage (functionality)	Business Critical	Business Value	Critical Information/Data	Reliability	Security	Compliance	Flexibility towards Change	Support Current Operations	Support Future Needs/Goals
Adolph, 1996	x		x	x		x	x			x	x	x	x	x	x	x	x	x		x		x
Alderson & Shah, 1999	x		x	x				x		x	x			x	x			x		x	x	x
Almonaies et al., 2010	x	x	x	x		x	x	x	x	x	x		x		x	x	x	x		x		
Arisholm & Briand, 2006			x	x			x	x		x			x	x		x				x		
Aversano & Tortorella, 2004	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bennett & Rajlich, 2000	x		x	x		x	x		x	x	x			x	x	x	x		x	x	x	x
Bennett, 1994	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x			x		x
Biachi et al., 2001		x	x	x				x		x	x		x	x		x				x	x	
Bisbal et al., 1997	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x		x	x	x
Bisbal et al., 1999	x	x	x	x					x				x	x		x				x	x	
Boyer & Mili, 2011			x	x					x		x	x	x			x	x	x	x	x	x	
Brandon, 2011		x	x	x		x		x		x	x	x	x	x	x	x	x	x	x	x	x	
Brodie & Stonebraker, 1993	x	x	x	x		x	x	x		x	x		x	x	x	x	x			x	x	x
Brodie, 1992	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x		x	x	
Cimitile et al., 2001	x	x	x	x			x	x	x		x	x	x	x	x	x	x			x		x
Cormella-Dorda, 2000	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Cosentino, 2014	x	x	x	x		x	x	x	x	x		x	x	x		x			x	x	x	
CSC White Paper, n.d.			x			x		x		x	x			x	x	x			x	x	x	x
De Lucia et al., 2008	x	x	x	x			x	x	x		x	x	x	x	x	x		x		x		
DeDominicis, 2015		x	x					x			x	x	x	x			x	x	x	x		
Galinium & Shahbaz, 2014	x		x	x		x	x	x		x	x			x	x	x	x	x	x	x	x	x
Gotlieb, 1993							x			x	x	x	x	x	x	x	x			x	x	x
Groosman et al., 2015		x	x		x	x	x	x	x	x	x			x	x		x			x		x

Harrison & Avgeriou, 2008	x		x								x	x					x	x				
Kaur et al., 2015	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x		x		x
Khadka et al., 2014	x	x	x	x		x		x	x	x	x		x	x	x	x	x		x	x	x	
Krumm et al., 1999		x					x	x				x	x			x		x		x		
Kuipers, 2002	x	x	x	x	x		x	x		x	x	x	x	x		x	x		x	x		
McDavitt et al., 2013	x	x	x	x			x	x		x			x	x		x		x		x	x	
McGiffin, 2013		x	x								x					x	x		x	x	x	
Mehta & Heineman. 2002	x	x	x	x			x	x	x	x	x	x	x		x	x		x		x		x
Mishra et al., 2009	x		x	x				x			x		x	x	x	x	x			x	x	
Nannery, 2000		x	x	x	x	x	x	x		x	x	x	x	x	x	x					x	
OnBase White Paper, n.d.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Plotkin et al., 2014						x		x		x	x	x	x	x	x	x	x	x	x	x		x
Ransom et al., 1998	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Seacord, 2003			x	x			x		x	x	x	x	x	x	x		x	x		x	x	x
Sneed, 1995	x	x	x	x			x	x		x	x	x	x		x	x	x	x		x	x	
Sommerville, 2011	x	x	x	x			x	x	x		x		x	x		x			x	x	x	x
Stevenson & Pols. 2004		x	x	x			x	x	x	x	x	x	x			x	x			x		
Tilley & Smith, 1995	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x			x	x	
Tromp & Hofman, 2003		x		x			x			x	x	x		x		x			x	x	x	x
Ulrich, 2000	x	x		x				x	x				x		x	x	x				x	x
Visaggio, 2001	x	x	x	x			x	x	x			x	x		x							
Warren & Ransom, 2002	x		x	x		x		x	x	x		x	x	x	x	x	x			x	x	x
Weiderman et al., 1997	x	x	x	x		x	x	x		x		x	x		x	x	x	x		x	x	x
Wiggerts, 1997		x	x	x		x	x	x				x	x	x						x	x	x
Wilde et al., 2003	x		x	x			x	x		x		x	x			x				x		

Appendix 3 – Survey

The Characteristics of a Legacy System from a Future-Oriented Perspective

Legacy Systems

The purpose of this survey is to test a framework that is developed to help determine when an IT system can be regarded as a legacy system. The framework is based on a future-oriented perspective of what a legacy system is. This perspective will be tested in the survey as well. The duration of the survey is approx. 5 minutes and participation is anonymous. Survey results will be made available to those who are interested.

Are you aware of what a legacy system is? *

- ○ yes
- ○ no

Future-Oriented Perspective

Please select the statements that you consider to be true: a legacy system is ... *

- ☐ ... any system that is in production
- ☐ ... a system that runs on obsolete technologies
- ☐ ... a system of which its cost exceed the financial benefits it produces
- ☐ ... a system that is unaligned with current business needs and operations
- ☐ ... a system that is unaligned with future business needs and goals

In your opinion, is it important that an IT system is aligned to the business strategy (i.e. future business needs and goals)? Please explain briefly. *

Please select the statements that you consider to be true: aligning an IT system with the business strategy (i.e. future needs and goals) means ... *

- ☐ ... knowing a system can already support future needs and goals
- ☐ ... ensuring a system can change in time to support future needs and goals
- ☐ ... having the resources available to change a system when necessary
- ☐ ... knowing what the organization's future needs and goals are
- ☐ ... ensuring the business strategy takes into account the capabilities of IT
- ☐ other ...

Please rank the following statements. *

	strongly disagree	disagree	neutral	agree	strongly agree
It is feasible to align an IT system with the business strategy					
IT is capable of predicting business needs and goals					
Business opportunities are lost because of legacy systems					
It is possible to predict the future of technology					
Obsolete technology is no problem if a system is performing well					
Obsolete technology is no problem if a system is aligned to the business strategy					
The age of a system is insignificant if it is performing well					
The age of a system is insignificant if it is aligned to the business strategy					
If a system's costs exceed financial benefits the system is unaligned to the business					

Characteristics of a Legacy System

Please rate how significant each factor is in making an IT system inflexible towards change.If you believe a factor is not significant at all please select NA. If you believe a factor is missing please add it in the open text box. *

	very insignificant	insignificant	significant	very significant	not applicable
Insufficient documentation					
Isolation (troublesome integration)					
Poor design					
Spaghetti code (adhering to no standard)					
Expired license					
Limited No. of vendors/suppliers					
Massive size (code, functionality, users, etc.)					
High interdependence					
Embeds a lot of business logic/knowledge					
Lack of skills/staff (for support and maintenance)					

Please rate how significant each factor is in ensuring an IT system is aligned to the business. If you believe a factor is not significant at all please select NA. If you believe a factor is missing please add it in the open text box. *

	very insignificant	insignificant	significant	very significant	not applicable
Performs effectively					
Satisfies users					
Covers (beyond specified context					
Supports critical operations					
Contributes significant economic value					
Stores vital information					
Performs reliably (low risk of failure)					
Is secure					
Is compliant with rules and regulations					

Demographics

What is your fuction or role? *

- C-level Executive
- Developer
- IT operator
- Manager
- Consultant
- System Analyst
- Business Analyst
- Product Owner
- Scrum Master
- Researcher
- Professor
- [ ]

In which industry are you active? *

- Technology
- Banking & Finance
- Education
- Telecommunications
- Consulting
- Media & Entertainment
- Government
- Healthcare
- Retail
- Transportation
- Insurance
- Manufacturing
- Utilities
- [ ]

End of Survey

Thank you for participating! Would you like to receive the results of this survey? If yes please write your email address in the open text box. *

- No
- Yes [ ]