

The selection and use of system development methodologies

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ABSTRACT

Selection of system development methodologies (SDMs) are driven from characteristics of the organisation using the SDM, and the project to which the SDM is applied by individuals working on it. No figure is available for the number of SDMs, but the need exists to select the correct SDM to use. Although previous selection models only focus on the project, the organisation and individual were identified as also having an influence, thus the selection should be made on organisational level, project level, and individual level. This research aimed at identifying characteristics of the organisation, project, and individual levels that can guide the selection of an SDM. This led to the construction of a conceptual model for this research. Using the conceptual model and empirical research, a survey was used as the research method. Statistical analysis was used to identify which characteristics of the organisation, project and individual have an influence on the selection and use of an SDM. It was determined that the various characteristics of each level influence which SDM should be used, either directly or indirectly. The influence these characteristics have on the selection is presented in a theoretical framework based on the conceptual model constructed. This addresses the need for the organisation, project and individual to be involved in the selection of an SDM to use. This research will impact future research about contingency, and the selection of SDMs that “fit” the organisation, project, and the individual. This theoretical framework could be expanded to propose the SDM to use, refining the influence of the identified characteristics on the decision.

Key terms: *system development methodology, SDM, contingency, selection, framework.*

OPSOMMING

Die seleksie en gebruik van 'n stelselontwikkeling metodologie (SDM) word gedryf deur die eienskappe van die organisasie wat die SDM gebruik, die projek waarop die SDM toegepas word, en deur die individue van die projek. Daar bestaan 'n behoefte om die korrekte SDM te selekteer en te gebruik, alhoewel geen getal beskikbaar is rakende die aantal SDMs wat bestaan nie. Alhoewel daar vorige seleksiemodelle bestaan, fokus hul net op die projek, maar die organisasie en die projek het ook 'n invloed op die seleksie – daarom moet die seleksie en gebruik op die organisasie-, projek- en individuele vlak gedoen word. Hierdie navorsing poog om die eienskappe van die organisasie, projek en individu te identifiseer wat die seleksie van 'n SDM beïnvloed. Dit het gely tot die konstruksie van 'n konseptuele model wat opgestel is vir hierdie navorsing. Deur van hierdie konseptuele model gebruik te maak, tesame met empiriese navorsing is 'n vraelys opgestel en gebruik om data in te samel. Statistiese analise is gedoen om die eienskappe van die organisasie, projek en individu te identifiseer wat die seleksie en gebruik van 'n SDM beïnvloed. Daar is bevind dat verskeie eienskappe van elke vlak die seleksie en gebruik van 'n SDM óf direk óf indirek beïnvloed. Hierdie verwantskappe van die eienskappe word voorgestel in 'n teoretiese raamwerk gebaseer op die konseptuele model wat opgestel is. Hierdie raamwerk spreek die behoefte aan wat bestaan vir die seleksie en gebruik van 'n SDM op organisasie-, projek- en individuele vlak. Hierdie navorsing beïnvloed toekomstige navorsing rakende die gebeurlikheids-benadering, seleksie en gebruik van 'n SDM sodat dit “pas” in die organisasie, projek en individu. Dié teoretiese raamwerk kan verder uitgebrei word om 'n enkele SDM te voorspel wat gebruik moet word. Dit verwantskappe wat geïdentifiseer is kan ook verder verfyn word.

Sleutel terme: *stelselontwikkeling metodologie, SDM, gebeurlikheidsbenadering, seleksie, raamwerk.*

TSHOBOKANYO

Go tlhopha mekgwa ya go tlhama ditsamaiso kgotsa system development methodologies (SDMs) go tlhotlhelediwa ke dinonofa tse setlamo se tlhaolwang ka tsone se se dirisang SDM, le porojeke e SDM e dirisiwang mo go yone ke batho ba ba dirang mo go yone. Di SDM ga di na palo, mme go na le tlhokego ya gore go tlhophiwe SDM e e siameng gore go dirisiwe yone. Le fa dimmotlolo tsa nako e e fetileng tsa tlhopho di tsepa mogopolo mo porojekeng fela, setlamo le motho ka bongwe di ne tsa tlhaolwa jaaka tse le tsone di nang le tlhotlheletso, ka jalo tlhopho e tshwanetse go dirwa go ya ka boemo jwa setlamo, boemo jwa porojeke, le boemo jwa motho ka bongwe. Boikaelelo jwa patlisiso eno e ne e le go tlhaola boemo jwa dinonofa tse setlamo, porojeke le motho ka bongwe di tlhaolwang ka tsone tse di ka kaelang tlhopho ya SDM. Seno se ne sa felela ka go bopa mmotlolo wa patlisiso eno mo kgopolong le go o tlhama. Go dirisa mmotlolo o o bopilweng mo kgopolong le patlisiso ka maitemogelo a se se diragetseng, go ne ga dirisiwa lenaane la dipotso jaaka mokgwa wa go dira patlisiso. Go ne ga sekasekwa dipalo ka kelotlhoko go bona gore ke dinonofa dife tse di tlhaolang setlamo, porojeke le motho ka bongwe tse di nang le tlhotlheletso ya go tlhophiwa ga SDM le tiriso ya yone. Go ne ga dirwa tshwetso ya gore dinonofa tseno tse di farologaneng tsa boemo bongwe le bongwe di na le tlhotlheletso ya gore go dirisiwe SDM efe, ka tlhamalalo kgotsa ka tsela e e seng ya ka tlhamalalo. Tlhotlheletso e dinonofa tseno di nang le yone mo tlhophong e bontshiwa ka thulaganyo e e sa ntseng e le mo kgopolong fela e e theilweng go mmotlolo o o bopilweng mo kgopolong o o tlhamilweng. Seno se diragatsa tlhokego ya gore setlamo, porojeke le motho ka bongwe di nne le seabe mo tlhophong ya gore go dirisiwe SDM efe. Patlisiso eno e tla ama patlisiso ya mo isagweng ka ga tiragalo e e ka nnang ya direga mo isagweng, le tlhopho ya di SDM tse di "tshwanelang" setlamo, porojeke le motho ka bongwe. Thulaganyo e e sa ntseng e le mo kgopolong fela eno e ka nna ya atosiwa gore e tshitshinye gore go dirisiwe SDM efe, e ka nna ya tokafatsa tlhotlheletso ya dinonofa tse di tlhaotsweng mo tshwetsong eno.

Mareo a a botlhokwa: *mokgwa wa go tlhama ditsamaiso, SDM, tiragalo e e ka nnang ya direga mo isagweng, tlhopho, thulaganyo.*

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
CVF	Competing Values Framework
DB	Database
DBMS	Database Management System
DSS	Decision Support System
ES	Expert System
IS	Information System
ISD	Information Systems Department
ISM	Information System Manager
KMO	Kaiser-Meyer-Olkin measure
PCA	Principal Component Analysis
PM	Project Management
PMP	Project Management Process
SDM	System Development Methodology
SE	Standard Error

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CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

1.1 INTRODUCTION

In this chapter, the problem is stated which has led to this research of constructing a theoretical framework to be used when selecting a system development methodology (SDM) to use. This framework will include all three levels of influence (the organisation, project, and individual). This will be followed by the aim and objectives of the research. Important terminology used in this study will be explained, followed by the research methods used. The final section will provide an overview of the structure of this dissertation.

1.2 PROBLEM STATEMENT

In 1991, it was estimated that more than 800 SDMs existed (Modha *et al.*, 1990:473), rising in only four years to more than a thousand (Lazarusli, 2013:32). SDMs have been used to create better quality systems and in a more formal manner. Risk of failure increases when an SDM is not used (Lemétayer, 2010:10), however, some organisations make a conscious decision not to use an SDM (Huisman *et al.*, 2006:41) since it is costly, and some projects run over budget or behind schedule. The use of an SDM did not prevent this, as many developers still used no formal SDM in 1997 (Griffin & Brandyberry, 2010:4). In more recent years, the younger developers tend to adopt SDMs, but also accepted the old-time work practices (Huisman *et al.*, 2006:41).

The theory of Rogers (1995) classifies an SDM as a contingent innovation, meaning that the SDM should be accepted at different levels, namely the organisation, project and the individuals. The context in which the software will be developed is always unique and shaped by the technology and culture within an organisation (Fitzgerald *et al.*, 2002:111). Avison and Fitzgerald (2003b:25) also stated that an SDM is appropriate for some given circumstances. The appropriate SDM should satisfy the requirements of all three levels of the organisation, project and individual as all these levels will make a contribution to the selection of an SDM.

Each SDM can be changed or altered for a specific organisation (tailoring) (Fitzgerald *et al.*, 2002:147), with versions of the methodologies sometimes being published. Project managers need to select an SDM from all those described in literature, leading to a difficulty in selecting an appropriate SDM (Avison & Fitzgerald, 2003b:575; Charvat, 2003; Cockburn, 2000:71; Griffin & Brandyberry, 2010:7; Lemétayer, 2010:92; Mnkandla & Dwolatzky, 2007; Sheffield *et al.*, 2011:11; Vavpotič & Vasilecas, 2012:136).

From within the literature, there exists a need to select an appropriate SDM, and researchers attempted to propose different types of tools to assist in the selection. These include proposed *guidelines* (Avison & Fitzgerald, 2003a; Modha *et al.*, 1990; Zhu, 2002), *tools* (Mnkandla & Dwolatzky, 2007), *frameworks* (Avison & Fitzgerald, 2003b; Charvat, 2003; Fitzgerald *et al.*, 2002; Taromirad & Ramsin, 2008), *expert systems* (Al Ahmar, 2010; Zaied *et al.*, 2013), and *decision models* (Cockburn, 2001; Dyck & Majchrzak, 2012; Vavpotič & Vasilecas, 2012). Most of these only focus on the project level, and do not take into consideration the organisational and individual level. Most of these techniques are fragmented, focusing on a group of SDMs or a family thereof.

Huisman (2013:2) states that the contingency of system development methodologies occurs when the SDM fits the project, as well as the context. Organisations, project managers, as well as all individual role-players should be satisfied when an SDM is chosen. If it is only compatible at the project level, it may not satisfy the issues at the organisational and individual levels. Fitzgerald *et al.* (2002:12-17) propose a framework illustrating that some elements, for example, the characteristics of the developers and the development context shape the method used. These elements, as well as the culture in the organisation (Huisman, 2013:9), also shape what SDM must be selected.

As there are many SDMs available, a theoretical framework will be developed in this study for the use of selecting an appropriate SDM for the organisation, project and individual. As existing frameworks already address the project level, more focus will be placed on the other two levels, incorporating the existing selection frameworks. Organisations will save money once they choose the SDM most suitable for all three levels, and pay less on the wrong choice of methodologies. Drawing up a framework to be used by organisations to choose the correct SDM may increase the throughput of projects, lower budget projects, and see more projects delivered on time, within scope.

1.3 RESEARCH AIMS AND OBJECTIVES

The main aim of the research is to propose a theoretical framework (selection model) for the selection of a suitable SDM. Objectives are as follows:

- i Identify the characteristics influencing the selection of an SDM on an organisational level.
- ii Identify the characteristics influencing the selection of an SDM on a project level.
- iii Identify the characteristics influencing the selection of an SDM on an individual level.
- iv Based on the characteristics, the theoretical framework will be developed.

1.4 EXPLANATION OF IMPORTANT TERMS

Clarification of the following key terms used throughout this dissertation is given as follows:

- A **system development methodology** (SDM), as defined in chapter 2: “formally prescribes how to execute and manage the collection of process models of the methods in a specific way, together with the integrated philosophy, to develop and document an information system (IS), or any part thereof, with the help of some tools and/or custom techniques in a specific situation/environment. Each development can be broken down into smaller parts where the SDM is still enforced. Agile methodologies include iterations for incremental development for continual improvement of the IS.”
- **Contingency** is defined as the fitting of the SDM to the project, as well as its context. For this study, contingency will be expanded to the fitting of the SDM to the organisation, project, and the individual.
- The **organisation, project** and **individual** are those *entities* that need to select and use an SDM, such as an organisation in various projects, which in turn will consist of various individuals. All these have an influence on the selection and use of an SDM.

- The **selection** and **use** of an SDM are regarded as the same in this study. Selecting an SDM will lead to the use thereof, where the use of the SDM will also indicate that it has been selected for use.

1.5 RESEARCH DESIGN AND METHODOLOGY

This research study lent itself to the use of the positivistic research paradigm using a survey, which made it possible to gather data from a large group of people in a short time. A thorough review was conducted on relevant literature regarding the selection models for use of SDMs. The literature was obtained through searches on search engines (*Google* and *Google Scholar*) and the following databases: *ScienceDirect*, *EbscoHost*, *ACM Digital Library*, *IEEE Xplore* and *Scopus*.

The participants were situated in South Africa, pursuing a job in Information Technology. A total of 166 people participated in this study, having joined a group on a social media platform, including *LinkedIn*, *Facebook*, and forums, making up a convenient sample.

A questionnaire was used to gather data, as well as *Google Forum*, and the data was analysed statistically with the use of the *SPSS* software package. Statistical analysis included descriptive statistics, *t*-tests, ANOVA, regression and correlation.

1.6 CHAPTER OUTLINE

The chapters of this dissertation are divided as follows:

Chapter 1: Introduction and problem statement

This chapter provided an introduction and background information for this study, as well as the aims and objectives.

Chapter 2: Selection of Information System Development Methodologies

This chapter will provide an overview of the current literature relevant to this study. Firstly, the definition of an SDM, followed by the eras of SDMs which have led to the contingency approach. This will be followed by an overview of the selection techniques that already

exists, leading to the evaluation of the techniques against the three levels of influence involved in the selection of an SDM.

Chapter 3: Research Methodology

Chapter 3 will discuss the research methodology chosen for this research, notably the positivistic paradigm and a survey used and implemented.

Chapter 4: Results – description of participants included in sample

This chapter will provide the descriptive statistics and factor analysis results obtained from the respondents involved in this study.

Chapter 5: Results on the organisational level

Chapter 5 will present further results according to the first objective stated in section 1.1, identifying characteristics on an organisational level to influence the selection and use of SDMs.

Chapter 6: Results on the project level

Chapter 6 will present further results according to the second objective stated in section 1.1, identifying characteristics on a project level to influence the selection and use of SDMs.

Chapter 7: Results on the individual level

Chapter 7 will present further results according to the third objective stated at section 1.1, identifying characteristics on an individual level to influence selection and use of SDMs.

Chapter 8: Results on the theoretical foundation

Chapter 8 will present further results relating to the theoretical foundation used for this study (as stated in Chapter 2, section 2.5)

Chapter 9: Discussion and conclusion

This chapter will provide the discussion, theoretical framework, and the final comments from this research. The limitations and contributions of this research are also discussed, leading to the conclusion of this research.

1.7 SUMMARY

This chapter has provided the background information and research problem stating the need for selecting an SDM that is suited to the organisation, the project and the individual. This led to the aims and objectives used for this study. Some important terminology has been explained for this study. The next chapter will provide an overview of the current literature relating to contingency and selection techniques that currently exist.

CHAPTER 2

SELECTION OF SYSTEM DEVELOPMENT METHODOLOGIES

2.1 INTRODUCTION

A System Development Methodology (SDM) focuses on the following two aspects: an information system, and a methodology used for the development thereof. In this section, a definition of an SDM is formulated as used during this research, followed by the eras of existence. Contingency will be discussed, indicating that a need for choosing the right methodology existed long before the term 'contingency' had been used. Thereafter, the existing methods for choosing methodologies will be stated and classified as a framework, technique, guideline, tool, expert system (ES) or decision-making model. This will be followed by the advantages and disadvantages of the use of selection models. This chapter will conclude with the theoretical foundation upon which this study is based, followed by evaluation of the existing selection models.

2.2 SYSTEM DEVELOPMENT METHODOLOGIES

An information system (IS) is a way of providing processes and information which are useful to the members and clients of an organisation using it. These systems usually help the organisation to operate more effectively when implemented (Avison & Fitzgerald, 2003b:3). The methodology of developing systems may be defined in various ways.

2.2.1 Definition of a System Development Methodology

A System Development Methodology (SDM) is the framework being used to structure, plan and control the series of steps and procedures that need to be followed when developing an IS, breaking the process into phases and executing them (Lazarusli, 2013:30; Turbit, 2004:1; Zaied *et al.*, 2013:20). During the planning, the SDM acts as the framework to state which activities should be executed at each stage of development (Al Ahmar, 2010:143; Avison & Fitzgerald, 2003b:26; Charvat, 2003:264; Dyck & Majchrzak, 2012:5301). An SDM also includes techniques, tools, documentation, management and training to develop a system (Avison & Fitzgerald, 2003a:80).

Different from a method, an SDM includes a set of rationales, a philosophic view and other characteristics (Avison & Fitzgerald, 2003b:24; Ruparelia, 2010:8), and whilst a method *describes* a methodology *prescribes*. The philosophic view of an SDM guides the selection of goals, principles, specific methods as well as tools, making effective use of Information Technology (IT). SDMs can be applied and tailored for specific situations (Avison & Fitzgerald, 2003b:26; Charvat, 2003:264; livari *et al.*, 1999:1; Turbit, 2004:1; Vavpotic & Bajec, 2009:528).

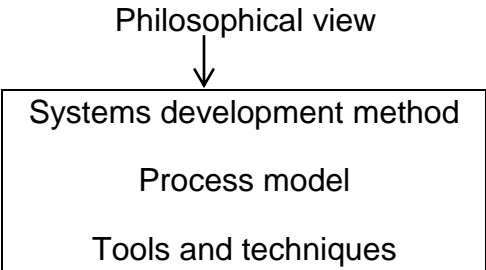
Avison and Fitzgerald (2003b:25) state that different SDMs usually address different objectives, but should provide the following:

- 1 Accurate recording of the requirements of the IS.
- 2 A systematic method of development for effective monitoring.
- 3 An IS in the appropriate time limit, at an acceptable cost.
- 4 An IS which is well documented, and makes the maintenance easy.
- 5 Indications of changes that have to be made early in the development process.
- 6 A system which is accepted by the people who are affected by it.

The following table (Table 2-1) lists some definitions of SDMs, providing the source and definition.

Table 2-1: Various definitions of SDMs

Source	Definition
Avison & Fitzgerald (2003b:568)	“A systems development methodology is a recommended means to achieve the development, or part of the development, of information systems based on a set of rationales and an underlying philosophy that supports, justifies and makes coherent such a recommendation for a particular context. The recommended means usually includes the identification of phases, procedures, tasks, rules, techniques, guidelines, documentation and tools. They might also include recommendations concerning the management and organisation of the approach and the identification and training of the participants.”

<p>Huisman & livari (2006:32)</p>	<p>SDM covers a total of four components:</p> <ol style="list-style-type: none"> 1. SD Approach The underlying theories and assumptions that the authors of the methodology believe in and shaped the development of the methodology. Example: Object-Oriented 2. SD Methods The methods are the activities performed to produce a better product. Example: IE or OMT 3. SD process models The SD process models are the sequencing and iteration of activities included in the method used to perform the philosophical view. These process models define how the system will be developed. Example: Spiral Model 4. SD Tools and Techniques Tools and Techniques assists the team in performing the tasks needed to be performed in systems development. Example: ER diagrams <p>The above four components can be graphically illustrated as follow:</p> <div style="text-align: center;">  <pre> graph TD A[Philosophical view] --> B[Systems development method Process model Tools and techniques] </pre> </div>
<p>Zaied <i>et al.</i> (2013:20)</p>	<p>“[An] information system development methodology refers to the framework that is used to structure, plan, and control the process of developing an information system.”</p>
<p>Al Ahmar (2010:143)</p>	<p>“[A] software development methodology is a formalized approach that is used to plan and manage the process of developing a software system.”</p>
<p>Dyck & Majchrzak (2012:5301)</p>	<p>“[A] software development methodology (SDM) as a reference model for the development of software describing the various statuses of the corresponding software projects.”</p>
<p>Avison & Fitzgerald (2003b:24)</p>	<p>“An information system development methodology can be defined as: a collection of procedures, techniques, tools, and documentation aids which will help system developers to implement a new information system. A methodology consists of phases, where each phase consist of its sub-phases, which will guide the systems developers in their choice of the techniques that might be appropriate at each stage of the project and also help them plan, manage, control and evaluate</p>

	information system projects.” A methodology has an underlying philosophy, otherwise it will be a basic method to be followed.
Grey (2011:11)	“An ASDM [Agile Software Development Methodology] is an adaptable/flexible SDM that focuses on integrated communication, user involvement, minimized documentation, and incremental and iterative development to deliver quickly and as often as possible in a constantly changing environment.”
Ruparelia (2010:8)	“SDLC is a conceptual framework or process that considers the structure of the stages involved in the development of an application from its initial feasibility study through to its deployment in the field and maintenance”
Chan & Thong (2009:803)	“A systems development methodology (SDM), defined as a documented collection of policies, processes, and procedures, is commonly used by software development teams to improve the software development process in terms of increased productivity of information technology (IT) personnel and higher quality of the final IT solutions”
Fitzgerald <i>et al.</i> (2002:5)	An information system is “[a] coherent and systematic approach, based on a particular philosophy of systems development, which will guide developers on what steps to take, how these steps should be performed and why these steps are important in the development of an information system.”

From Table 2-1, the following definition can be formulated:

A System Development Methodology (SDM) formally prescribes how to execute and manage the collection of process models of the methods in a specific way, together with the integrated philosophy, to develop and document an information system (IS), or any part thereof, with the help of some tools and/or custom techniques in a specific situation/environment. Each development can be broken down into smaller parts where the SDM is still enforced. Agile methodologies include iterations for incremental development for continual improvement of the IS.

The above definition will be used during the rest of the study.

2.2.2 Eras of methodologies

Avison and Fitzgerald (2003a:79; 2003b:576) have identified four eras of methodologies while studying the evolution and development of methodologies:

- Pre-methodology era – This era lasted until the early 1970s, during which information systems were developed without the use of a formalised methodology. Development was considered as programming in which technical problems were solved. The

programmers worked individually, with poor management and control of the project, using their experience and skills together with 'rule of thumb' (Avison & Fitzgerald, 2003a:79-80; 2003b:576).

- Early-methodology era – This era began in the late 1970s and continued until the early 1980s, characterised by the approach to develop computer-based applications (software), with an approach that focused on the identification of phases and stages. It was thought to help with control and to enable the better management of the development of systems. It became known as the System Development Life Cycle (SDLC), thought to be more disciplined (Avison & Fitzgerald, 2003a:79; 2003b:577).
- Methodology era – This era began in the late 1980s when a number of approaches emerged for systems development, and lasted until the late 1990s. Methodologies came into existence to address the limitations posed by the SDLC, such as long development times, and rigorous or inflexible requirements (Zaied *et al.*, 2013:20). Avison and Fitzgerald (2003a:80) state that the term “methodology” was most probably used for the first time, to describe the different approaches to system development, and resulted in the proliferation of methodologies (Avison & Fitzgerald, 2003a:80; 2003b:578). Methodologies of various kinds were created and introduced to the public.

In 1990 Modha *et al.* (1990:473) reported that more than 800 SDMs were available, regarding this as excessive, then in 1994 Lazarusli (2013:32) found already more than 1,000 methodologies, an increase of over 200 methodologies in four years (Aborowa & Taylor, 2011:11). In 2013, many researches again stated that methodologies were excessive, with software engineers having a problem selecting the appropriate methodology to use for development (Hanafiah & Kasirun, 2007:111; livari *et al.*, 1999:1; Zaied *et al.*, 2013:20). These included commercial as well as in-house developed SDMs (Lazarusli, 2013:32), as all had similar patterns (Khan & Beg, 2013:8).

- Era of methodology reassessment – This era began in the late 1990s, and is characterised by a serious evaluation of the concepts and the practicality of the methodologies developed in the previous era. Avison and Fitzgerald (2003b:583-586) identified 14 criticisms against these methodologies, stating that they had still not shortened the time to develop an IS, or improved systems (Avison & Fitzgerald,

2003b:586). Because the systems had not improved, organisations sought better ways to develop them. The following have been identified as the direction in which the organisations are moving:

- Ad hoc development – developers return to the pre-methodology era when no formalised methodology was used. This is characterised by trial-and-error and the experience of the programmer (Avison & Fitzgerald, 2003b:586).
- Continuous development of methodologies – some organisations still seek the development of new methodologies, and try to improve those being used (Avison & Fitzgerald, 2003b:587).
- Incremental development – systems are improved by developing newer versions based on the older ones. In this way, the part of the system already working is not changed, but new features are added to the existing one. This allows for requirements to change over time, using agile methodologies to develop them (Avison & Fitzgerald, 2003a:81).
- External development – some organisations began the development of systems from an external one. In this manner they moved to the purchase of packaged software, or by outsourcing the development to third parties. This usually contained requisite features, but more were built to be self-tailored (Avison & Fitzgerald, 2003a:82; 2003b:588).
- Outsourcing – organisations are no longer concerned about how systems are developed or what methodology is used for development. They only focus on the effectiveness of the system that is developed by third party organisations (Avison & Fitzgerald, 2003a:82).
- Contingency – the methodologies from the previous era were developed with a step-by-step prescription to fit into ideal situations. No provision was made for any tailoring, and no ideal situation exists (Avison & Fitzgerald, 2003a:82). Some began to see the structure presented, but only used tools and techniques that were appropriate to the situation. This is known as the ‘contingency approach’ whereby the characteristics of the project are taken into account when choosing an appropriate methodology (Avison & Fitzgerald, 2003b:587). Huisman (2013) recently found that organisations in South Africa are part of the contingency, as

only as few as 18% of the participating organisations used an SDM as a standard, whilst the rest used it as a general guideline, or adapted it on a project-by-project basis.

- Developing with tools – organisations have begun to use tools for development. Their faith in these tools determines the success of the system, whereby tools included, for instance, automatic code generation. However, using these tools without following a methodology is like the ad hoc direction stated above (Avison & Fitzgerald, 2003a:81).

With the emerging of agile SDMs today (Huisman, 2013:6; Van Dijk, 2011:4; Vavpotič & Vasilecas, 2012:136; Zaied *et al.*, 2013:20), and the increase in mobile technologies and applications available (Al Ahmar, 2010:142), it may be that the next era has begun.

2.2.3 Contingency

As mentioned above, in the discussion of the methodology era, SDMs became excessive, with users stuck with the choice of which SDM to choose. Many think “one size fits all” (Cockburn, 2000:71; Van Dijk, 2011:4), but every project requires a different “one” (Khan & Beg, 2013:8; Lemétayer, 2010:1; Van Dijk, 2011:2) as one SDM is more suited for a specific project than another (Burns & Dennis, 1985:19; Clara, 2013:273). Aborowa and Taylor (2011:11) state that selection is the process through which an SDM is chosen for the organisation and assured to get the most appropriate system that meet its needs. Contingent are those factors which will define what changes should be made to tailor the SDM for a specific project or other (Van Dijk, 2011:2). Huisman (2013:2) also defines ‘contingency’ as a fitting of the methodology to the project, as well as its context. By selecting the most appropriate SDM, the changes needed through contingency will be the minimum. If it is to be tailored extensively it could be that the chosen SDM may not be the correct SDM.

Van Dijk (2011:3) states that a methodology is suitable for a project only if the contingency factors “fit” the project situation, namely, those factors which will define what changes should be made to get the SDM required for the project (Van Dijk, 2011:2). An SDM will not completely “fit” all projects, but will only be a best fit for some particular ones (Clara, 2013:273; Turbit, 2004:4). Fitzgerald *et al.* (2002:7,109) state that information systems

are developed in a specific organisation, for a specific situation, and therefore there is no methodology that is fit for every developmental project of an information system. During an investigation, it has been found that there is a lack of well-defined characteristic parameters for any SDM, where it is applied to a real project (Mandal & Pal, 2013:9).

Many researchers have proposed or developed frameworks that suggest the manner in which an SDM is applied or engaged (see Avison & Fitzgerald, 2003b:593-603), but Aborowa and Taylor (2011:33) conclude that no framework will work in all the situations and cannot be followed by all organisations (Fitzgerald *et al.*, 2002:148; Verma *et al.*, 2014:1068). Such a conclusion is also reached by Griffin and Brandyberry (2010:7), and these frameworks are only documents that provide guidelines for selection (Mnkandla & Dwolatzky, 2007:1). This makes it difficult for organisations engaged in third party development to choose the correct methodology, and it has been addressed by both the researchers (see below for existing techniques, section 2.3) and practitioners (Vavpotic & Vasilecas, 2011:107). Other organisations conducting their own in-house development of IS also have difficulty with the essential activity of selecting the appropriate methodology based on the requirements of the IS, the type of project (Lemétayer, 2010:1; Vavpotič & Vasilecas, 2012:136; Zaied *et al.*, 2013:20), and the project environment (Van Dijk, 2011:2). The activity of selecting the correct methodology is becoming more important than before (Burns & Dennis, 1985:22; Charvat, 2003:18). For other organisations, the first step would be to choose the right SDM, but in the case where 'off-the-shelf' systems are needed, it should be to select the correct product for their organisation (Nazir *et al.*, 2012:1).

Organisations do not usually have the resources or time to stay informed about the existing and developing methodologies, which leads to selections with which they are known and these SDMs may not necessary be updated to the latest version available, limiting their choices (Vavpotic & Vasilecas, 2011:109-110, 2012:160), but old methodologies are too rigid for today's project environments (Lemétayer, 2010:2). The project manager is responsible for choosing the correct methodology before the initiation stage of a project (Van Dijk, 2011:3), whilst team members should also be aware of the strengths and weaknesses of methodologies as these will positively influence their decision on the use of one (Khan & Beg, 2013:8). Selecting the right SDM will have an influence on the success of the project (Khan & Beg, 2013:12; Sheffield *et al.*, 2011:3; Vavpotic & Vasilecas, 2011:118). Van Dijk (2011:2) argues that the contingency factors

related to the project environment will contribute to the fit between an SDM, and top management. The project team project management and the customer must all agree upon the SDM for the project to be successful (Vavpotic & Vasilecas, 2011:118).

The need to map the capabilities of an SDM and the characteristics of a project are thus becoming more important and contingency factors have to be better known by developers to fit the correct SDM to the project (Burns & Dennis, 1985:22; Van Dijk, 2011:4), since choosing the correct SDM is much more complex and challenging than answering “yes” or “no” to a question (Mnkandla & Dwolatzky, 2007:1; Van Dijk, 2011:3). With some experience of the industry, Fitzgerald *et al.* (2002) developed a framework to illustrate the nature of the development of ISs and state that the SDM that is chosen will be adapted or changed in some way, depending on certain factors. The framework takes into account some of the critiques against every SDM, for example, those ones different for a particular type of project and not covering everything as expected. Figure 2-1 illustrates the developed framework.

The formalised method, for any formally documented SDM, either commercial or in-house SDMs, may also be included in computer aided software engineering (CASE) tools which assist the development process (Fitzgerald *et al.*, 2002:13). The roles the methods play justify why they are used, and influence how they are applied. These form part of the rationale behind the choice and help with the project management of the development process, reducing risks and uncertainties. With the knowledge from previous development processes, the roles of methods can standardise the process, enabling inter-changeability among developers (Fitzgerald *et al.*, 2002:13-14).

The complex context in which information systems are developed are taken into account in the framework. The development context is real and unique to every development process. There may be times when some characteristics are similar but not the same for two projects. The formalised methods, mentioned above, prescribe how the developmental situation should be tackled, but the characteristics of the context, shape how these must be actually applied (Fitzgerald *et al.*, 2002:14-16).

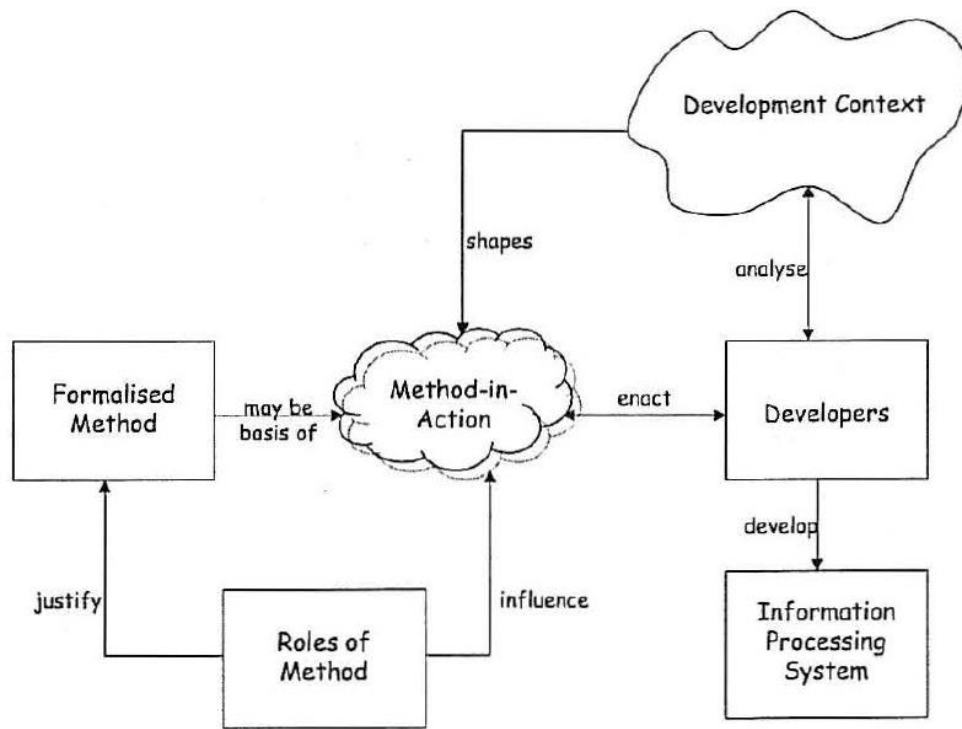


Figure 2-1: Framework for development of information systems (Fitzgerald *et al.*, 2002:12)

The formalised methods are merely a framework for the developers to use, but it is they who develop the system and not the method. Frameworks cannot be applied without human experience, and therefore the developers play an important role in the choice and use of methods, including in their choice all the affected stakeholders, users, analysts, designers, programmers and clients. The developer “*analyses* the development context and uniquely *enacts* the method-in-action to *develop* an information processing system” (Fitzgerald *et al.*, 2002:16). Currently, information systems have unique processing mechanisms, some with common characteristics and therefore grouped into ‘families’, affecting the method-in-action which is needed to develop a system (Fitzgerald *et al.*, 2002:16-17).

The Method-in-Action cloud in Figure 2-1 illustrates the use of methodologies in reality. Methodologies are rarely applied in practice as they are intended to be, and not always as a whole. The dashed line around the method-in-action component illustrates that a formalised methodology may be used, but not completely as originally suggested to be applied. Fitzgerald *et al.* (2002:13) states that no two developers will interpret and apply one method in the same way, nor will one developer apply the same method unchanged

in different situations. The cloud with the dashed line illustrates that the method applied will be uniquely enacted by the developers (Fitzgerald *et al.*, 2002:194).

From Figure 2-1, the cloud symbolising the method-in-action will be shaped and will sometimes be larger if the selected SDM needs to be adapted or tailored extensively. The cloud will be smaller if the selected SDM does not need to be adapted or tailored in addressing the developers, the context, and the roles of the method. Selecting an SDM which addresses the organisation, project, and the individuals will reduce the cloud, thus reducing the adaption of the SDM before using it.

2.3 EXISTING SELECTION TECHNIQUES

In this section, existing techniques of selecting an SDM will be discussed. Many researchers have proposed guidelines (Cockburn, 2001; Modha *et al.*, 1990; Zhu, 2002:), tools (Mnkandla & Dwolatzky, 2007), frameworks (Avison & Fitzgerald, 2003b; Cockburn, 2000; Fitzgerald *et al.*, 2002; Klopper *et al.*, 2007; Taromirad & Ramsin, 2008), expert systems (Al Ahmar, 2010; Verma *et al.*, 2014:1068; Zaied *et al.*, 2013), and decision models (Cockburn, 2001; Dyck & Majchrzak, 2012; Vavpotič & Vasilecas, 2012) to help with the selection of an SDM.

In the following sections, 2.3.1 to 2.3.4, the existing techniques of the literature will be discussed, some of which addresses the selection of an SDM, while others address contingency, shaping the choice.

2.3.1 Selection guidelines

The following are guidelines to selecting which SDM is to be the best for the organisation and projects, lessening the tailoring.

2.3.1.1 Uncertainty model of Naumann *et al.* (1980)

Modha *et al.* (1990) reviewed six selection techniques presented before 1990, one of which gave guidelines for selecting an SDM based on project uncertainty. Naumann *et*

al. (1980:273) developed these selection guidelines for Requirements Determination Strategy, but they could also be applied to select an SDM (Modha *et al.*, 1990:474). Each project is calculated to a certain level of uncertainty, at which time it is more likely that it will change during the course of development. With low levels of uncertainty, the project will probably be executed as planned. Naumann *et al.* (1980:273) list the following four contingencies as contributing to the overall uncertainty of the project (the first step):

- 1 Project size: where a large project has a high uncertainty and a smaller project has a low uncertainty.
- 2 Degree of structure: where a high and well-defined structure leads to low uncertainty, and a poor structure leads to high uncertainty.
- 3 User-task comprehension: where the uncertainty is high when users do not understand and agree upon the tasks, and low uncertainty when the users agree about and understand the tasks.
- 4 Developer-task proficiency: where the vast experience of the developing team leads to low uncertainty, and less-experienced teams have high uncertainty levels.

These contingencies are mapped onto a worksheet, with an uncertainty score calculated for the project.

As on Figure 2-2 (below) the contingencies are listed for a specific project, and each evaluated to determine how it contributes to the uncertainty of the project. After this evaluation, the marks in each column are summarised, multiplied by the uncertainty factor, then calculated. This number is regarded as the uncertainty score by which the requirements are calculated and techniques decided on.

The next step is matching the score to a type of requirement determination technique: a score of less than four makes use of interviews to determine the requirements, whilst for medium scores requirements are derived from the existing IS, or from system characteristics. With a high score of more than 13 the requirements are determined through prototyping. Based on these techniques of determining requirements, the appropriate SDM can be selected (Modha *et al.*, 1990). In the case of high uncertainty, Agile SDMs are used, and with high certainty, the more traditional SDMs are used.

CONTINGENCIES		REQUIREMENTS UNCERTAINTY		
		Low	Moderate	High
(1) Project size				
(a)	Project development time	Short		Long ×
(b)	Total project development cost	Small		Large ×
(2) Degree of structure				
(a)	Goal clarity	High	×	Low
(b)	Existence and definition of general model of process	Well defined	×	Poorly defined
(3) User-task comprehension				
(a)	Problem understanding	High	×	Low
(b)	Application system understanding	High		Low ×
(4) Developer task comprehension				
(a)	Previous experience with same or similar system	High		Low ×
(b)	Previous experience in user area	High	×	Low
(5) Overall assessment				
	Sum of scores		4	4
	Times uncertainty factor	0	1	2
		0	4	8
	Uncertainty score	12		

Figure 2-2: Worksheet used by Naumann *et al.* (1980:281)

2.3.1.2 Guidelines of Zhu (2002)

Zhu (2002:345) proposes the following two guidelines:

- 1 When the uncertainty of a project is high, the determination of requirements should be iterative. Prototyping is suggested in this situation.
- 2 When the system to be developed are complex, a structured System Development Life Cycle is suggested.

2.3.1.3 Objectives and guidelines of Charvat (2003)

Before an organisation can select an SDM, the following objectives should be taken into account (Charvat, 2003:60):

- The strategy and competitiveness of the company.

- The size of both the team and the project.
- The priority of the project.
- The criticality of the project to the company.
- How much flexibility is allowed and needed.

The above guidelines focus on the uncertainty and include requirements, complexity and objectives to propose guidelines. These lead to proposing the families of SDMs that should be used, not just a specific one. Only one of these proposed guidelines recognises the place of the project from within the organisation.

2.3.2 Selection decision models

There are a number of models available for making selecting decisions. These include decision support systems proposed and developed.

2.3.2.1 Decision Rule Matrix

A decision model based on a hybrid of the weighted scoring model and a rule-based model proposed by Vavpotič and Vasilecas (2012:136) is not for selecting SDMs but rather to suggest which are most appropriate for a specific situation, that is, a type of project. Properties of projects and SDMs are entered into matrixes, where the models process two matrixes and provide a set of suitable SDMs. An expert on SDMs enters their properties as well as the rules into the decision rule matrix. The project manager allocates weights to the properties of the specific project before the processing starts (Vavpotič & Vasilecas, 2012:139-140).

The matrix containing the decision rules is divided into sub matrixes, in which each SDM property crosses with a property of a project (as illustrated in Figure 2-3, below). The sub matrix is then drawn up for one project characteristic to one SDM characteristic, of the project and of the SDM, which may have many value options.

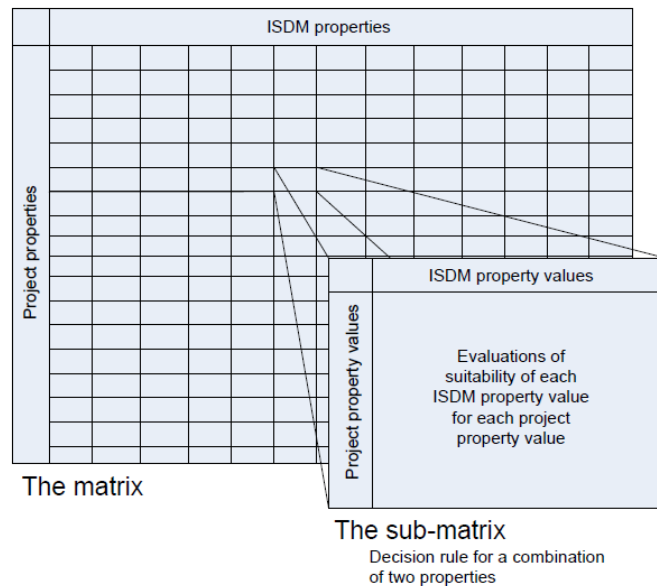


Figure 2-3: The decision rule matrix divided into sub matrixes (Vavpotič & Vasilecas, 2012:147)

In Figure 2-4 (below), the intersection (sub matrix) of the implementation and integration of the SDM to the criticality of the project is illustrated as it will be entered into the decision rule matrix (Vavpotič & Vasilecas, 2012:147).

Literature is studied to derive weights as the columns and rows intersect in the sub matrix. The weights take the form of a Likert-scale from -2 up to 2, where -2 suggests it is *very unsuitable* and 2 suggests *very suitable*. The weights are then assigned according to the literature, for example, Avison and Fitzgerald (2003). One advantage of this matrix is that it is designed to be expanded by adding new rules (Vavpotič & Vasilecas, 2012:148).

Another matrix is maintained with a natural language explanation of each intersecting SDM property and project property. This is done as the explanatory component of an expert system, helping the business user understand the proposed suitable SDM the model produces (Vavpotič & Vasilecas, 2012:148). The core for each SDM is mathematically calculated, as explained in Vavpotič & Vasilecas (2012:149-150).

		Implementation and integration		
		no description	moderate detail	in detail
Criticality of a system to be developed	loss of comfort	0	2	0
	loss of discretionary money	-1	1	1
	loss of essential money	-2	1	1
	loss of life	-2	-1	2

Figure 2-4: Example of a sub matrix (Vavpotič & Vasilecas, 2012:148)

2.3.2.2 Selection model for Decision Support Systems (DSS)

Arinze (1991) developed a contingency model of selecting the appropriate SDM for decision support systems (DSS). Figure 2-5 illustrates the role of DSS methodologies in and how the real world influences the chosen methodology (see the section 2.3.3, p 25) (Arinze, 1991:159).

The following links are identified in the figure:

- 1 Link [1] shows that the real world analysis initiates the development of the DSS (Arinze, 1991:156).
- 2 Link [2a] helps with understanding the decision process, while link [2b] indicates that the methodology provides a means of describing the decision process (Arinze, 1991:156).
- 3 Links [3a] and [3b] evolve the understanding of the decision model (Arinze, 1991:156-157).
- 4 Information and insight into the nature of the required change process are indicated by links [4a] and [4b], and link [4c] indicates that the methodology specifies those illustrated by links [4a] and [4b] (Arinze, 1991:157).
- 5 The architecture of the DSS is built upon the decision model (link [5a]), the change process (link [5b]), and the guidelines of the methodology (link [5c]). All these guides the implementation of the architecture (Arinze, 1991:157).

- 6 The decision supported process is implemented by the use of the constructed DSS (link [6a]) and takes form in the change process (link [6b]), evolves and is maintained using the DSS methodology (link [6c]) (Arinze, 1991:157).

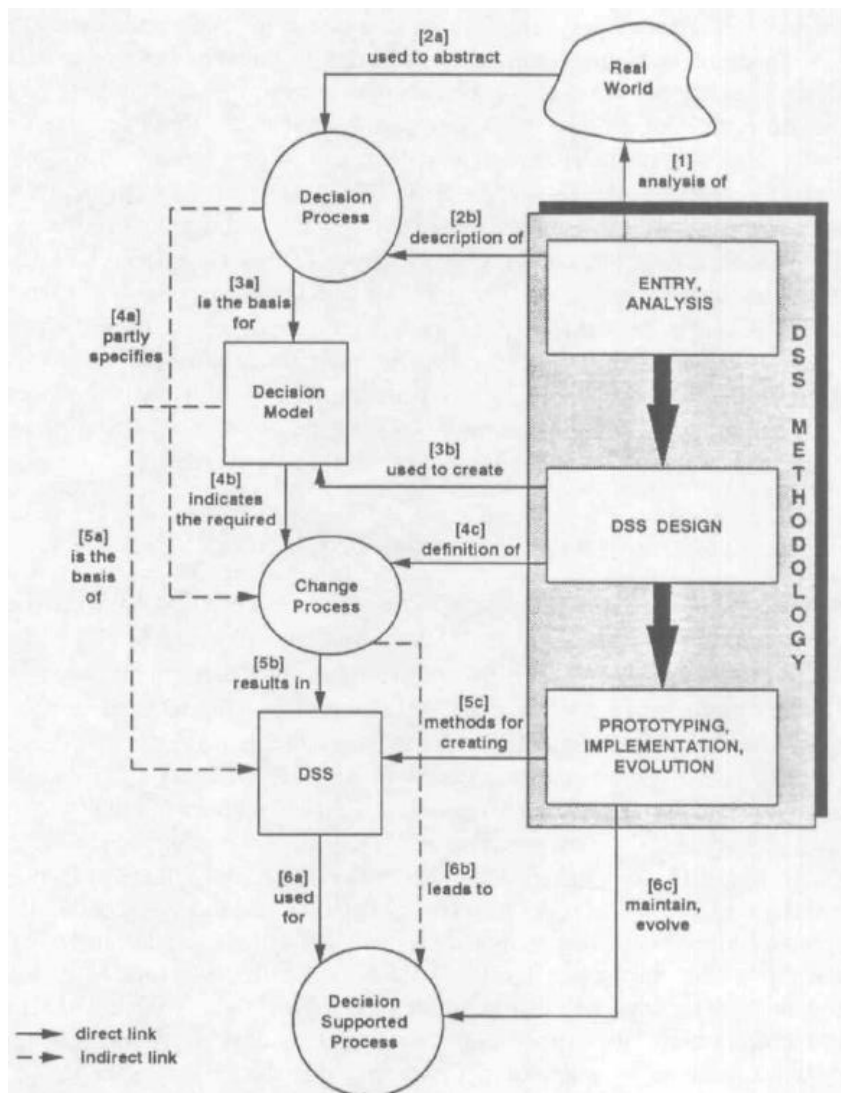


Figure 2-5: The role of DSS methodologies

All the above links represent some methods used for the development of the DSS methodology. The links that originated from the methodologies illustrate the methods used for lowering the uncertainty of ill-structured problem solving. This framework and theories enable more informed decision making when a methodology must be chosen, based on the problem context and the individual strengths (Arinze, 1991:159).

Seven methodologies have been identified by authors, and through extensive research, Arinze (1991:160) set up Table 2-2. The paradigms of each of the links of DSS development are indicated at the top (Arinze, 1991:159-160).

Table 2-2: Feature analysis of DSS development

	Real-world analysis [1]	Abstraction of Decision Process [2b]	Creating Decision Model [3c]	Defined Change Process [4c]	DSS Development [5c]		DSS Maintenance and Evolution [6c]
					Model	Data	
Stabell	●	●●	●	●	○	○	○
Martin	●	●●	●●	●	○	○	○
Sprague and Carleon	●	●	●●	●	●	●	●
Keen and Morton	●●	●	●	●	●	●	●
Arton and Ginzberg	●●	●	●	●	○	○	●
Menkus	●	○	○	●	●	●●	●
Youngh	●	●	●●	●	●	●	●

In Table 2-2 (above), the symbol ○ indicates that the paradigm is not addressed in the methodology, the symbol ● indicates partially or adequately addressed paradigms, and ●● indicates that the paradigms are extensively dealt with in the methodology (Arinze, 1991:160).

This table represents a selection framework that could be used to select an SDM for development of DSSs. The process-driven methodologies are identified as the most comprehensive methodologies. As the table indicates the shortages in some areas, the developers may choose to avoid those methodologies in which the paradigms are not addressed. This table may also be used together with the analyst’s evaluation of the uncertainty of the aspects of the development (Arinze, 1991:160).

This process may be useful to evaluate SDMs, indicating which SDMs may be suitable, and which not. The manner in which the paradigms are addressed may be expanded to more than the three options used in Table 2-2 (above) for providing more accurate evaluations.

2.3.3 Expert systems for selections

The following are expert systems for selections.

2.3.3.1 Rule-based expert system of Zaied *et al.* (2013)

Zaied *et al.* (2013:20) proposes an expert system (ES) for the selection of SDMs, which evolves through the following three main parts:

- 1 Identification phase, in which the problem situations are being classified as a technical problem situation, a social problem situation, a socio-technical problem situation or a complex problem situation.
- 2 Determination phase, in which a list of suitable methodologies is identified based on the classification situation as identified by the first phase.
- 3 Selection phase, in which an appropriate methodology is selected based on the rules of the ES.

Within the knowledge base of this ES, 21 methodologies were used, and 101 rules were constructed for the selection of the correct SDM. Some of these IF-THEN rules (Zaied *et al.*, 2013:25-26) are:

- “Rule 1: **IF** problem is structured and defined and **IF** problem has an unclear objective and **IF** problem is not combined of behavior, organisation, and, technical factors **THEN** the problem situation is a **technical problem**”
- “Rule 19: **IF** the problem situation is technical problem and **IF** user has not a clear requirement and **IF** user has not a critical System and **IF** user has not a complex System and **IF** user will not use unfamiliar technology and **IF** user has not unstable Requirements and **IF** user has not a short time for developing his system **THEN** the suitable ISDMs are the Traditional methodologies”
- “Rule 89: **IF** the suitable ISDMs are Traditional methodologies and **IF** the user wants to focus on the analysis and design of the processes of a large scale System **THEN** the suitable methodology **is** the Structured Analysis Design and Implementation of Information Systems (STRADIS) Methodology”.

2.3.3.2 The SDM-ES

Al Ahmar (2010:146) developed an ES which consisted of facts and rules derived from the literature. The researchers list important SDM characteristics then evaluate these by assigning values as 0 (*poor*), 0.5 (*good*) and 1.0 (*excellent*). The following table represents the characteristics and the weights assigned according to the methodology.

Table 2-3: Example of methodology weights against characteristics (Al Ahmar, 2010:145)

Usefulness in developing systems	Iterative	Extreme Programming
with short time schedule	Excellent	Excellent
with unclear user requirements	Good	Excellent
with unfamiliar technology	Good	Poor
that are complex	Good	Poor
that are reliable	Good	Good
with schedule visibility	Excellent	Good

When all the weights are assigned, the sum is calculated for each methodology. If, for example, the user states that the system is complex, a weight of 0.5 is assigned to the iterative methodology, and 0 to extreme programming (XP). The methodologies are then ranked and the one with the highest score is the most appropriate. This implies that the methodology only scored *good* or *excellent* for each characteristic (Al Ahmar, 2010:146).

Both the above ESs were published within five years (2010-2015). Apart from those discussed previously in this section, these propose a specific SDM, and not families from which a choice should be further made. The ES proposed by Zaided *et al.* (2013) uses 21 SDM and 101 rules, while the ES proposed by Al Ahmar (2010) used only nine SDMs and six selection criteria, although it is mentioned that more SDMs could be added without changing the system. More SDMs and selection criteria are needed, as well as looking at the organisation and individuals involved.

2.3.3.3 Expert system with Likert scale

In 2014, Verma *et al.* (2014:1068) proposed an ES with Likert scale (rule-based expert system) to be used by system engineers to choose the best SDM for projects. The ES does not provide one particular SDM for a particular project, but a set of familiar SDMs as guidance for the project. Users, those determining the SDM to use, will have to provide information to the ES regarding the characteristics of the project.

A five-point Likert scale has been used to determine the appropriateness of the feature to the SDM, by which 1 represents *Poor*, 2 *Fair*, 3 *Average*, 4 *Good*, and 5 *Excellent*. The following table represents a comparison between the waterfall, spiral, and prototype SDMs. The feature (or parameters) in the table are used in the ES (Verma *et al.*, 2014:1069).

Table 2-4: Comparison of the features between different SDMs

Features	Waterfall	Spiral	Prototype
Requirement specification	Beginning	Beginning	Beginning
Complexity of the system	Simple	Simple	Simple
Time schedule	Very low	Very low	Very low
Cost	Low or almost as estimated	Low or almost as estimated	Low or almost as estimated
Documentation	Necessary	Necessary	Necessary
Project size	Large scale	Large scale	Large scale
Change incorporate	Difficult	Difficult	Difficult

Some other rules have been included in the ES, like when documentation is a necessary and the requirements will not change or are stable, the waterfall SDM should be chosen; if the risk of the project is high, the spiral SDM should be chosen; and when the requirements are not defined, the prototype SDM should be automatically chosen (Verma *et al.*, 2014:1069).

2.3.4 Selection frameworks

The following section discusses the frameworks that have been proposed and developed.

2.3.4.1 Selection framework of Cockburn (2000)

Cockburn (2000:68) described a framework by selecting a methodology based on the size of the project (based on the number of people), four zones of criticality (based on the loss of life, essential money, discretionary money, and comfort) and several project priorities (Figure 2-6 below).

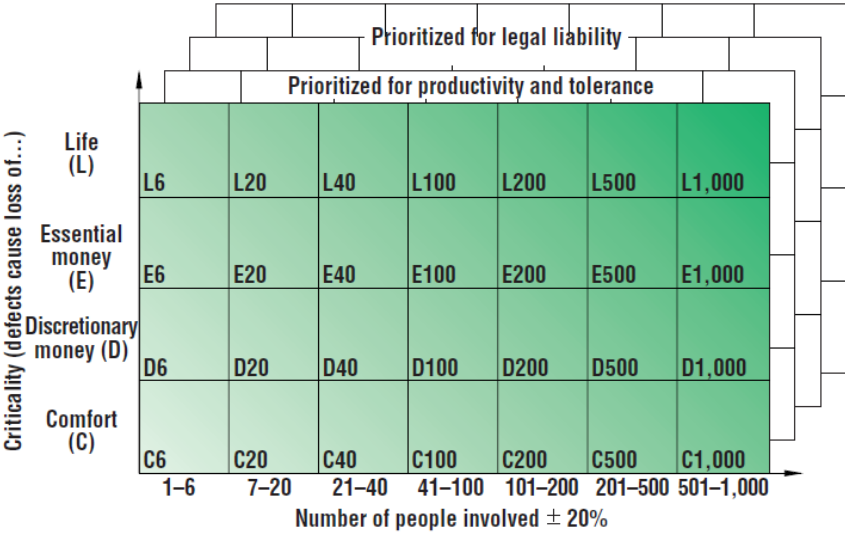


Figure 2-6: Framework proposed by Cockburn (2000:69)

As the number of people increases, the more tight communication should be present in the methodology, and as the criticality becomes denser, the tighter the controls should be. Based on each cell, the following four principles will help to identify the basic methodology (Charvat, 2003; Cockburn, 2000):

- 1 The larger the group the larger methodology needed (a larger methodology has more elements than the rest).
- 2 The more critical a system is the more visible correctness is needed in the construction.

- 3 A relatively small increase in the size or density of the methodology contributes a large amount to the cost of the project.
- 4 The most effective form of communication is interactive and face-to-face as it would be with a whiteboard.

After these four principles are dealt with, the preferences of the personnel will contribute to the selection of the final methodology (Cockburn, 2000:69).

2.3.4.2 Framework of Bjorn-Anderson

A much broader range of issues is addressed by the following criteria (Avison & Fitzgerald, 2003b:593; Klopper *et al.*, 2007:60):

- 1 Which research paradigms form the foundation of the methodology?
- 2 What are the underlying value systems?
- 3 In what context is a methodology useful?
- 4 To what extent is modification possible?
- 5 Does communication and documentation consider the user's dialect?
- 6 Does transferability exist?
- 7 Is the societal environment dealt with?
- 8 Is user participation encouraged?

The questions from the Bjorn-Anderson framework address a broader range, but these questions do not guide any person on how to adopt or select any one methodology to be used.

2.3.4.3 NIMSAD Framework

The Normative Information Model-based Systems Analysis and Design (NIMSAD) is based on the following three elements (Avison & Fitzgerald, 2003b:593):

- 1 The problem situation (the context of the methodology).
- 2 The intended problem solver (the user of the methodology).
- 3 The problem solving process (the methodology itself).

These three elements are expressed and evaluated by answering the following kinds of questions (Avison & Fitzgerald 2003b:593-595):

- Understand and identify the clients (their understandings, experiences, and commitments);
- Understand and identify the problem owners (their concerns and problems);
- Understand and identify the situation the SDM users are facing (is the diagnoses structured or unstructured);
- The beliefs, values and ethical positions of the SDM users;
- The philosophical views (science or system-based) of the SDM users; and
- Understanding the situation of concern (setting boundaries), and more.

NIMSAD also aims to evaluate the methodology before the adoption thereof, during the use of the methodology, and finally after the assessment of success of the methodology (Avison & Fitzgerald, 2003b:593).

2.3.4.4 Framework of Davis

The framework of Davis (Avison & Fitzgerald, 2003b:595) also tries to select a methodology based on the determination of requirement after an assessment of the uncertainty of the project, as with Naumann *et al.* (1980) in their model. Davis measures the uncertainty using the following four measures:

- 1 Complexity of the system.
- 2 The state of flux of the system.
- 3 The user component of the system.

4 The level of skills and experience of the analysts.

Based on the determined uncertainty, the appropriate method is chosen for determination of the requirements:

- For low levels of uncertainty, interviews are the most appropriate for determining the requirements.
- For medium levels of uncertainty, a process should be followed where requirements are synergised from the current IS.
- For high levels of uncertainty, a prototyping and evolutionary method would be better.

2.3.4.5 Framework of Avison and Taylor

Avison and Taylor identified the following five situations, as well as appropriate approaches to follow in them (Avison & Fitzgerald, 2003b:595):

- 1 A well-defined problem situation with a well-defined problem and clear requirements – the traditional SDLC is most appropriate.
- 2 A well-defined problem situation with a well-defined problem and unclear requirements – a prototyping approach would be most appropriate.
- 3 An unstructured problem situation with unclear objectives – a soft system approach is most appropriate.
- 4 High user-interaction systems – a people-focused approach is more appropriate.
- 5 Very unclear situations – a contingency approach is more appropriate.

2.3.4.6 Comprehensive Evaluation Framework for Agile Methodologies (CEFAM)

The Comprehensive Evaluation Framework for Agile Methodologies (CEFAM) is a comprehensive framework aimed at covering all the different aspects of agile methodologies (Taromirad & Ramsin, 2008:197). The evaluation criteria of the framework

have been divided into five categories, further subdivided into groups containing evaluation criteria which corresponds to a specific view of the relevant context, as seen in Figure 2-7 (below).

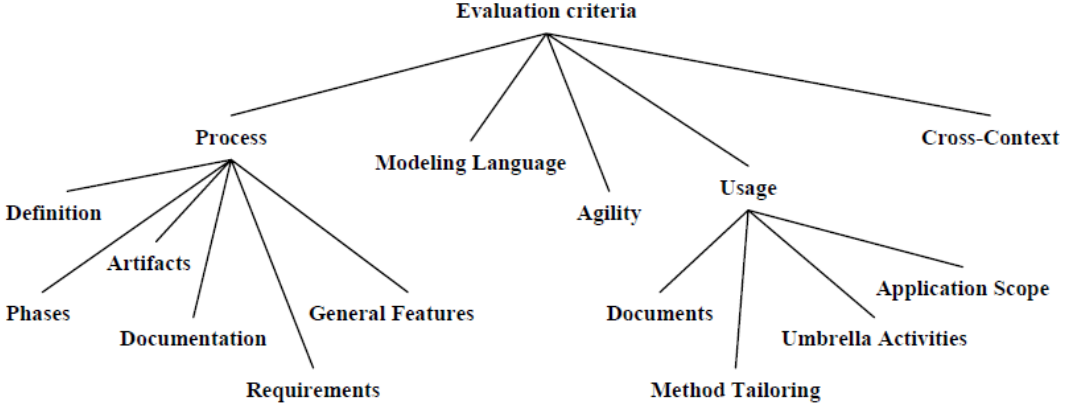


Figure 2-7: CEFAM framework hierarchy proposed by Taromirad and Ramsin (2008:197)

Quantitative values must be assigned to each evaluation criterion, which is converted into descriptive values, namely *Unacceptable* (less than or equal to 0.25), *Low* (greater than 0.25 and less than or equal to 0.5), *Medium* (greater than 0.5 and less than or equal to 0.75), and *High* (greater than 0.75, and less than or equal to 1.0). After assigning these values, the methodology with this highest overall score is considered the most appropriate (Taromirad & Ramsin, 2008:202).

2.3.4.7 Selection framework for agile practices

A selection framework was developed for agile methodologies, in which the philosophy is that the development process is a phenomenon. This is made up of two groups of activities, i.e., social and technical activities. As agile methodologies are customer-centric, this framework is also based on the values and priorities of the project, according to the customer (Mnkandla & Dwolatzky, 2007:1). The following figure illustrates the selection process of the proposed framework.

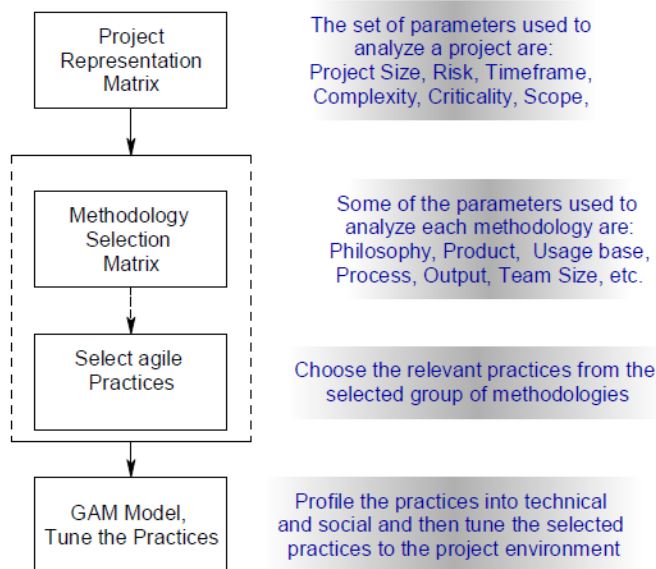


Figure 2-8: The selection process of the framework to select agile methodologies

The following two statements summarize the concepts the authors incorporated into the framework (Mnkandla & Dwolatzky, 2007:2):

- 1 The activities are driven by the values and priorities of the customer for a given project.
- 2 All activities should be classified as either social or technical activities.

The framework consists of three stages, where the second stage consists of two phases. The first stage is to determine the relevance of agile methodologies to the specific project. In a case of no conformation being needed for the relevance of agile methodologies to the project, the first phase may be omitted. The phases of the second stage are as follows: Phase 1 begins with the parameters of the project. In this phase, these parameters are used to determine how appropriate agile development is for the specific project. A selection matrix is used, as illustrated in Figure 2-9 (below) (Mnkandla & Dwolatzky, 2007:2).

The second stage is used to provide a list of methodologies that are most suitable to the project, according to the values provided by the customer. Each methodology identified in Figure 2-9, or by the customer, is analysed according to the nine parameters, as illustrated in Figure 2-10 (also below) (Mnkandla & Dwolatzky, 2007:3).

Project Parameters	Rating 0 to 5	Methodology Choice
Requirements Stability		
Project Size		
Development Timeframe		
Project Complexity		
Project Risk		

Figure 2-9: Methodology selection table for phase one

For the matrix in Figure 2-10 (below), the values and priorities of the customer are used to identify those methodologies which are most suitable for meeting the requirements of the project (Mnkandla & Dwolatzky, 2007:3).

The third stage takes the output of stage two as inputs in this stage. Agile methodologies must be chosen, and the details given to adapt the methodologies for the specific project. This stage also consists of three phases, i.e., phase one identifies practices that relate to people issues; phase two identifies practices that relate to technical issues; and phase three outlines the practical steps to be executed for tuning (Mnkandla & Dwolatzky, 2007:3). This proposed model has been automated, but must still be validated.

Parameters	XP	Crystal	Scrum
Methodology Philosophy			
Methodology Process			
Methodology Techniques and Tools			
Methodology Scope			
Methodology Outputs			
Adoption and Experience			
Methodology Product			
Roles and Responsibilities			
Support for Distributed Teams			

Figure 2-10: Matrix to analyse methodologies against the parameters for phase two

This toolbox only uses a family of SDMs – Agile, and can be extended at stage 1 when the project can be evaluated for different families of SDMs, not just Agile. This way more

SDMs could be included as only three are mentioned in the article (Figure 2-10, above), and nine are shown in the screen dumps (Figure 4 in Mnkandla & Dwolatzky, 2007:6).

2.3.5 Summary of the selection techniques

The following table summarises the selection techniques as discussed above. It provides an overview of the year in which the technique has been published, and whether it predicts the use of a specific or a general type of SDM to use. The application of these techniques are also stated as in the following table.

Table 2-5: Comparison of techniques

Author	Year	Par.	Application	General / Specific
Guidelines				
Naumann <i>et al.</i>	1982	2.3.1.1	Determining requirements	General
Zhu	2002	2.3.1.2	Uncertainty and complexity	General
Charvat	2003	2.3.1.3	Uncertainty	General
Decision models				
Vavpotic & Vasilecas	2012	2.3.2.1	Project suitability	General
Arinze	1991	2.3.2.2	Selection of SDMs	Specific
Expert systems				
Zaied <i>et al.</i>	2013	2.3.3.1	Problem situation	Specific
Ahmar	2010	2.3.3.2	Evaluation of characteristics	Specific
Verma <i>et al.</i>	2014	2.3.3.3	Selection of SDMs	General
Frameworks				
Cockburn	2000	2.3.4.1	Selection of SDM	Specific
Bjorn-Anderson	1984	2.3.4.2	Selection of SDM	Specific
NIMSAD	1994	2.3.4.3	Problem situation	General
Davis	1982	2.3.4.4	Uncertainty and requirements	General
Avison & Taylor	1996	2.3.4.5	Selection of SDMs	General
Taromirad & Ramsin	2008	2.3.4.6	Selection of SDMs	General
Mnkandla	2007	2.3.4.7	Selection of SDMs	General

Table 2-5 illustrates that two thirds of the techniques discussed only suggest a general (or family) of SDMs, from which others should then be chosen, but the techniques do not include how to make a further decision. Only one third of these techniques propose a specific SDM, but those are also only a few predefined which are usually only traditional SDMs, and not so much Agile SDMs.

2.4 ADVANTAGES AND DISADVANTAGES OF SELECTION TECHNIQUES

Avison and Fitzgerald (2003b:583) state that some organisations adopted an SDM, but that it was not necessarily an appropriate one for the project or organisation, and therefore they had to adopt another. Adopting another methodology did not always result in better development of systems, and some organisations cycled through methodologies. Rejecting these does not mean that they are necessarily bad, but perhaps the selection should be more controlled and readily available for users.

Having methods to select methodologies, users can easily experiment with these methods to broaden their knowledge about both projects and SDMs. With the model proposed by Vavpotič and Vasilecas (2012) at 2.3.2.1, the user can experiment without in-depth knowledge of the SDMs. They can enter values for projects and study the results to get to know the SDMs better. The suitability is more visible through these experiments for the more advanced users with knowledge of SDMs. This model is developed as a decision system which has an explanatory function by which every decision made is explained through the use of literature. Some models have been developed through an iterative nature (Burns & Dennis, 1985). Vavpotič & Vasilecas (2012:160) proposes the model to make the selection process easier, assisting managers to select the best suited SDM for a specific project.

Models that have been developed serve as tools to assist those needed to select SDMs, to make a more informed decision regarding the most suitable SDM for the project (Vavpotič & Vasilecas, 2012:138). The more experienced the user the more suitable an SDM can be identified through the use of tools (Lemétayer, 2010:26).

The use of methods does not always have a positive effect. If the users do not understand the environment of the project the answers to the characteristics of the project may not be accurate (Burns & Dennis, 1985:22). The user of the selection methods should also

have experience and skills in these methods, and the user's best judgment is applicable for the selecting of an SDM from the most suitable methodologies (Avison & Fitzgerald, 2003b:587). Any uncertainty in the user may result in another SDM being suggested as a suitable methodology (Burns & Dennis, 1985:22).

By following a contingent approach through these selection methods, the benefits of standardisation are lost as another methodology is selected for each project. Also, by changing methodologies, the users should acquire more skills as they differ between them. If certain models combine methods these combinations are untenable as the methods usually underlie different philosophic views and these may be contradictory (Avison & Fitzgerald, 2003b:587-588).

2.5 THEORETICAL FOUNDATION AND EVALUATION

Rogers' (2003) theory on the "Diffusion of Innovations" included the decision process, from gaining knowledge to the confirmation that the chosen innovation is helpful and correctly applied. It defined an innovation as any new idea, practice, or object as seen by the individual or another unit of adoption. This states that the idea, for example, may already exist, but it is new to the parties concerned. He further defines the diffusion of an innovation as the process whereby the new idea, practice, or object is communicated to the members of the social system over time (Rogers, 2003:5).

The model of the stages of the above theory is illustrated in Figure 2-11 (below).

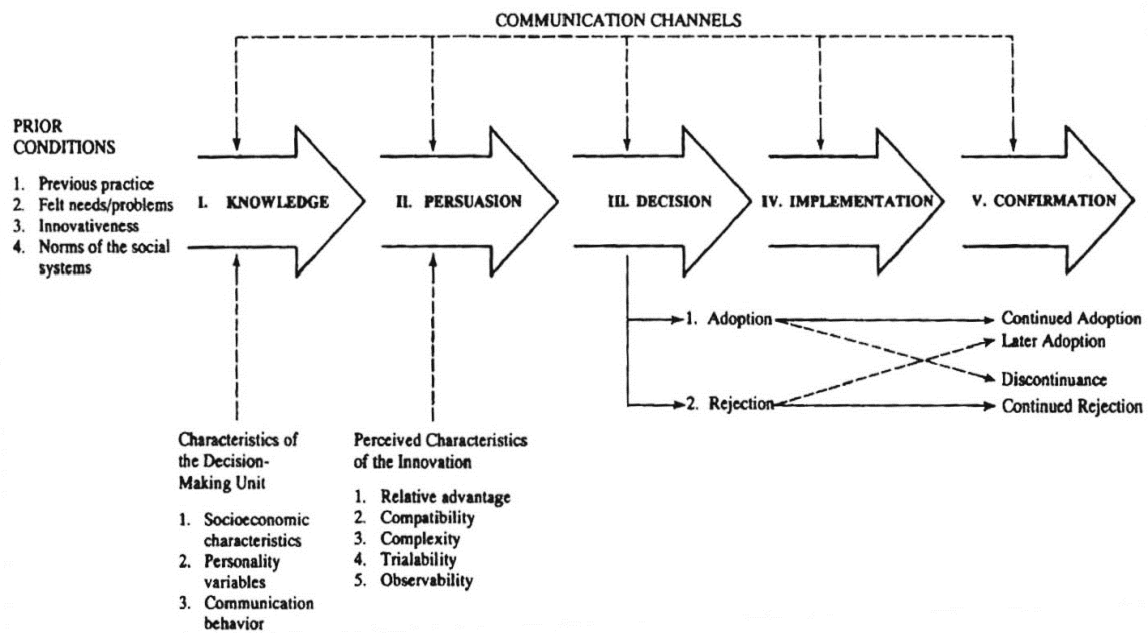


Figure 2-11: The stages of the theory of Rogers (2003:170)

The figure illustrates the following five stages to follow when an innovation is introduced and a decision needs to be made about its adoption:

1. In the *Knowledge* stage, an individual or the decision-making unit is introduced to the existence of an innovation. This includes the gathering and understanding of information, including how it functions (Rogers, 2003:169). It is shown that the following characteristics of the decision-making unit have an influence on the knowledge stage: socioeconomic characteristics, personality variables, and communication behaviour.
2. The next stage is that of *persuasion*. This stage sees the person or decision-making unit starting to form a favourable or unfavourable attitude towards the introduced innovation (Rogers, 2003:169). These characteristics of the innovation influence the persuasion which leads to the following stage: relative advantage, compatibility, complexity, trialability, and observability.
3. During the *decision* stage, the individual or decision-making unit executes some activities, or get involved in those activities, which leads to the adoption or the rejection of the innovation (Rogers, 2003:169).
4. The *implementation* stage occurs when the innovation is put into use by the individual or the decision-making unit (Rogers, 2003:169).

5. The last stage is known as *confirmation*, which occurs when an individual or the decision-making unit questions the previous decision process results, or reverses the outcome from the decision stage (Rogers, 2003:169). Depending on the results from stage 3 (the decision stage):

- When the innovation was adopted, the new outcome may be that the adopted innovation will be continued to be adopted or the adopted innovation may now be discontinued (Rogers, 2003:169).
- If the innovation was rejected, it may still be rejected or it may be adopted after this stage (Rogers, 2003:169).

An SDM can be classified as an innovation (Huisman 2000:53). The need of selection of methodologies fits with the second characteristic (compatibility) of the second stage (persuasion stage). The compatibility of the methodology to the situation will progress into the decision stage. Since the methodology must be applicable to the three levels of the organisation, project and individual, the following table will illustrate where the existing techniques as discussed in Section 2.3 are applicable.

Table 2-6: Applicability of techniques on organisation, project and individual

Technique Author	Paragraph	Applicability		
		Organisation	Project	Individual
Guidelines	2.3.1			
Naumann <i>et al.</i> (1982)	2.3.1.1		✓	
Zhu (2002)	2.3.1.2		✓	
Charvat (2003)	2.3.1.3	✓	✓	
Decision models	2.3.2			
Vavpotic & Vasilecas (2012)	2.3.2.1		✓	
Arinze (1991)	2.3.2.2		✓	
Expert systems	2.3.3			
Zaied <i>et al.</i> (2013)	2.3.3.1		✓	✓
Ahmar (2010)	2.3.3.2		✓	
Verma <i>et al.</i> (2014)	2.3.3.3		✓	
Frameworks	2.3.4			
Cockburn (2000)	2.3.4.1	✓	✓	
Bjorn-Anderson	2.3.4.2		✓	
NIMSAD	2.3.4.3		✓	
Davis	2.3.4.4	✓	✓	
Avison & Taylor	2.3.4.5		✓	
Taromirad & Ramsin (2008)	2.3.4.6		✓	
Mnkandla (2007)	2.3.4.7		✓	✓

From Table 2-6, it is clear that most of the existing techniques concentrates on the compatibility of the methodology with the project, but little emphasis is given to the fit of the organisation, and less to how the individual influences the use and selection of the SDM.

The theory of Fitzgerald *et al.* (2002) states the any SDM needs to be adapted to multiple levels. The first tailoring is for adjusting the SDM to fit the specific industry (macro-level tailoring at the industry level). After an SDM is available, another macro-level tailoring

occurs for the SDM to fit the organisation (Fitzgerald *et al.*, 2002:153-154). The first step is thus for the SDM to be accepted by the organisation. The second step is for the SDM to be accepted at the project level (micro-level tailoring) where the SDM accepted by the organisation is further tailored for the specific project (Fitzgerald *et al.*, 2002:154-155). Choosing the “right” SDM at organisational level, will lessen the amount of tailoring (contingency) of the SDM the organisation uses. The last step is for the SDM to fit the individual, as the people working on the project will also define how and which SDM will be selected and used.

This research will address the absence of a technique that addresses all three levels of influence in the decision-making process. The proposed framework in Chapter 9 will address the selection of an SDM which will “fit” all three levels of organisation, project and individual.

2.6 SUMMARY

This chapter summed up the current literature available on the selection techniques proposed. The definition of an SDM was formulated and used to discuss and evaluate the selection techniques identified. Chapter 3 will address the research methodology used to address the gap identified within this chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter will explain the research methodology used in this study, and how it has been implemented. Different paradigms are available, from which the positivistic research paradigm has been chosen. The characteristics applicable to the positivistic research paradigm and to this study will be discussed, followed by the different research methods and survey used in this study. The data collection methods and the data analysis techniques will be discussed as used in the research study. Using statistical analysis, the specific techniques used to analyse the data will be discussed.

3.2 Research design

The development of the research design consists of a series of decision-making on the following four dimensions (Blanche *et al.*, 2006:37):

- 1 Purpose – the purpose of the research.
- 2 Paradigm – the theoretical paradigm to be used for this type of research.
- 3 Context – the (unique) context in which the research will be conducted.
- 4 Techniques – those techniques used to collect and analyse the data.

Figure 3-1 illustrates these four dimensions forming the research design:

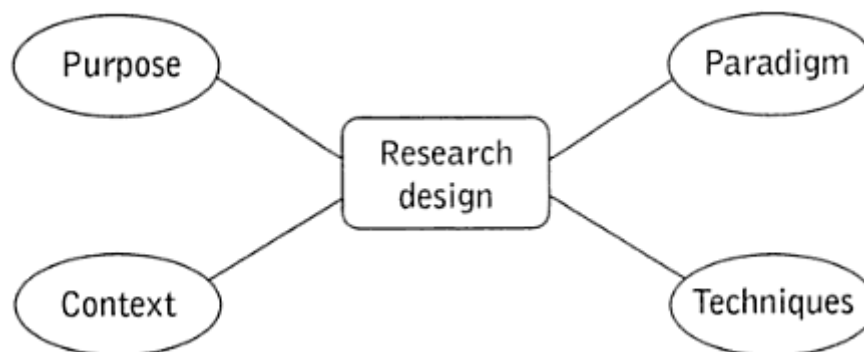


Figure 3-1: Four dimensions in research design (Blanche *et al.*, 2006:37)

The purpose and context of this research will be discussed below (3.3 and 3.4). The paradigm that was used will then be explained (3.5), as well as the techniques used (3.6, 3.7 and 3.8).

3.3 Purpose

The main purpose of the research is the construction and development of a theoretical framework (selection model) to select a suitable SDM to use during the development of a system. This will be done by identifying the influencing characteristics at the (1) organisational level, (2) project level, and (3) the individual level on the selection of an SDM.

3.4 Context

Avison and Fitzgerald (2003a:82) found that during the era of methodology reassessment, which they stated was the most recent era at that time, ad hoc development, continuous methodology development, incremental development, external development, outsourcing and contingency were the new directions in which organisations were moving. These new directions called for selection of methodologies to suit the organisation, project, and individual. Newly tailored methodologies are developed and published, increasing the number available.

The context of this research is the abovementioned era, to which a selection framework will be needed to guide some decisions regarding the SDM to use while developing a system. It is either a new version, based on a current system being used, or one based on the contingent use and tailoring of former methodologies.

The paradigms used are the next dimension in the formation of the research design, and will be discussed in the following paragraphs.

3.5 Paradigms

Oates (2006:282) and Maree (2010:47) state that a paradigm is a set of shared assumptions, ways or beliefs about fundamental aspects of reality that gives rise to a particular world-view. It consists of “interrelated ontological, epistemological, and methodical assumptions” (Blanche *et al.*, 2006:40). As different philosophical paradigms exist, all have their own ontology, that is, a different view of the nature of this world, and epistemology, that is, the way researchers gain knowledge about the relationship between the “knower and known” (Maree, 2010:47-48; Oates, 2006:282). A paradigm also provides the researcher with a rational perspective for the research, from which certain data collection methods are chosen (Chow & Cao, 2008:40). Various paradigms relevant to this research are discussed next.

3.5.1 Positivistic research paradigm

The positivistic research paradigm, one of the oldest, underlies the scientific method, which has been developed and established over 400 to 500 years. The latter has two basic assumptions on which research is based: (1) the world is ordered, not random, with patterns and regularities; and (2) this world can be objectively investigated. The aim of the positivistic research paradigm is to find those universal laws, patterns and regularities that describe all aspects of this world. Positivistic researchers do not let their values or beliefs interfere or shape the research, thus, they are not biased (Bertram & Christiansen, 2014:23; Oates, 2006:283). According to Maree (2010:145), quantitative (or positivistic) research is “a process that is systematic and objective in its ways of using numerical data from only a selected subgroup of a universe (or population) to generalise the findings to the universe that is being studied.”

3.5.2 Interpretive research paradigm

The interpretive research paradigm is the understanding of the social context (Oates, 2006:292), with the aim of understanding how people make sense of the world (Bertram & Christiansen, 2014:26; De Vos *et al.*, 2011:8), and not what the people will do (Bertram & Christiansen, 2014:26). It treats people as the origin of each of their thoughts, feelings,

and experiences on the social rather than individual level (Blanche *et al.*, 2006:278) and can be traced back to 1833, to the philosopher Wilhelm Dilthey (De Vos *et al.*, 2011:8). The researcher usually tries to discover meaning which may be embedded in text, such as photographs, transcriptions of interviews or documents (De Vos *et al.*, 2011:8).

Oates (2006:292) defines the qualitative (or interpretive) research as "... concerned with understanding the social context of an information system: the social processes by which it is developed and construed by people and through which it influences, and is influenced by, its social setting."

3.5.3 Critical social research paradigm

Defined by Oates (2006:296) as being "concerned with identifying power relations, conflicts and contradictions, and empowering people to eliminate them as sources of alienation and domination," critical research involves the reasoning of human beings who have the highest potential to eliminate the sources of alienation and domination where power relations, conflicts and contradictions are identified. Researchers try to remain objective, although followers of this paradigm admits that all actions of human beings are biased. This kind of research tries to explain *why* a certain world-view dominates others, and why this is argued to be the only correct way of doing things. The researcher tries to identify and change this conditions of domination (De Vos *et al.*, 2011:8-9; Oates, 2006:296-297).

3.5.4 Research paradigm used in this study

For this research study, the positivistic research paradigm was chosen. The main aim being to propose a theoretical framework (selection model) which can be used for the selection of a suitable SDM. Oates (2006:283) states that the use of the paradigm is to find those universal laws, patterns and regularities that describe some aspects of this world. As there exists a need for a model that will guide the selection of an SDM (see Chapter 1, 1.2), a framework to guide the selection will have to be based on the characteristics of the organisation level, project level and individual level. Identifying characteristics which influence the selection of an SDM, can be seen as patterns to guide

the action of selection. The positivistic research paradigm aims to get as close as possible to the truth when identifying the “general principals” from which the world are described (Bertram & Christiansen, 2014:23). When these general principals are combined a framework is constructed.

3.5.4.1 Characteristics

The following characteristics of the positivistic research paradigm are applicable to this research:

- The world exists independently of humans

The laws that are defined will still exist, regardless of any human. This world exists outside the minds of humans, as their thoughts are not evaluated or studied in this research (Oates, 2006:286). The framework developed will not be dependent on any individual.

- Measurement, modelling and hypotheses testing

By conducting research, the researcher makes observations and measurements from which models, in the form of hypotheses (the confirmation or the refutation thereof) and/or theories, are generated. These models describe how every aspect of the world out there exists (Oates, 2006:286). The characteristics that have an influence on the selection of an SDM, will be identified. These could lead to the formulation of hypotheses in which analysis of the data could prove or disprove them.

- Objectivity and a detached observer

The researcher in the positivistic research paradigm is detached, like a side-line observer, making unbiased conclusions from the facts gathered (De Vos *et al.*, 2011:63). Personal values and beliefs do not contribute to the facts that are discovered. Any contributions made towards the research should not guide the researcher into deriving specific results, therefore he/she should remain objective. As the scientific methods are applied in the positivistic research paradigm, the second assumption of this method is that the research will be objective (Oates, 2006:283-287). Through the techniques used (as discussed below), the researcher could not

influence the respondents or the data collected from them. The researcher was unbiased towards the results as the researcher did not meet any of the respondents in person.

- Quantitative data analysis

Mathematical and statistical analysis, particularly of qualitative data, provide a logical, objective means of using it¹ (Oates, 2006:286). The quantitative analysis performed on the data gathered will be discussed below (3.8.1).

- Universal laws (law-like)

Universal laws are used to make generalisations, independent of the human researcher, with the aim of describing these laws accurately (Blanche *et al.*, 2006:7; De Vos *et al.*, 2011:6; Oates, 2006:286). With the use of an objective research design using quantitative data analysis, these universal laws will be extracted to guide how organisations (with projects and individuals) will select a certain SDM, which may be used rigorously as a guideline or standard.

- Seeking to apply natural science to investigation

The application of natural science to research leads people to believe that the positivistic research paradigm is science (De Vos *et al.*, 2011:6). Through the collection of the data for this research, the questionnaire was sent out and stored electronically, then analysed using statistics, thus applying natural science to the research, from which conclusions have been drawn.

- Reality is studied, captured and understood

An objective reality exists from which cause-and-effect relationships could be drawn through theories, with the personal experiences eliminated (De Vos *et al.*, 2011:6), and this reality could be studied through the positivistic research paradigm (Blanche *et al.*, 2006:6). The real world is studied as organisations do need to select an SDM to use, and this study identifies the characteristics behind these selection decisions.

¹ Although 'data' is the Latin plural of datum it is generally treated as an uncountable 'mass' noun and so takes a singular verb (*Concise Oxford English Dictionary*, 2011, Eds. Stevenson & Waite).

- Ordered and regular

The first assumption of applying the scientific method as part of the positivistic research paradigm is that the world under study is ordered and regular, not random (Oates, 2006:283). It is believed that a certain SDM is not just chosen randomly, but some factors have an influence, as a person may favour one more because of familiarity, theoretical foundation, or other factors.

- Repeatability

Research in this paradigm can usually be conducted multiple times and yield similar results. This indicates that the research is repeatable and the result reliable (Oates, 2006:285,287). This study has been composed of a questionnaire which could be sent out many times to gather similar data. Applying the quantitative data analysis (statistical analysis), similar results could be delivered, confirming and adapting the framework constructed.

- Use of structured guidelines

The guidelines for conducting the research are defined before it is conducted, and kept throughout the research process (Leedy & Ormrod, 2005:95).

- Isolation of variables

The variables under study (see Table 3-1) were isolated and controlled for eliminating irrelevant ones which arose. Numerical data was collected and from which conclusions were drawn following analysis (Leedy & Ormrod, 2005:95).

- Deductive reasoning

Quantitative research makes use of deductive reasoning, moving from the general to specifics, as conclusions are drawn from hypotheses or theories (Leedy & Ormrod, 2005:95). The framework has been constructed through the data collected from the *general*, and the framework will be aimed at the *specific*.

Having discussed the purpose, context and paradigm dimensions of the research the fourth dimension is labelled as techniques. The research method, data collection techniques, as well as the data analysis will be discussed in the following section.

3.6 Research method

A research method is the approach by which the researcher tries to answer the research questions. Oates (2006:35) regards a research method as the strategy the researcher uses to answer the research questions. The following paragraphs will focus on the research methods associated with the positivistic research paradigm.

3.6.1 Surveys

Vogt (2007:76-90) states that the survey is the most familiar research method known, and tends to be efficient. It can generate much information at a low cost in time and effort and be conducted over the whole population as a census. Surveys are usually used when data needs to be collected from a large group, and then to generalise the patterns to a larger group (Leedy & Ormrod, 2005:187; Oates, 2006:93). Such data is still gathered in a standardised and systematic way and this research method may also be used with other paradigms (Oates, 2006:93). Surveys can assume many forms, including, structured face-to-face interviews, structured telephone interviews, written questionnaires, postal surveys, observations and documents (Leedy & Ormrod, 2005:188; Maree, 2010:157-158; Oates, 2006:93).

3.6.2 Experiments

Oates (2006:127) defines an experiment as “a strategy that investigates cause and effect relationships, seeking to prove or disprove a causal link between a factor and an observed outcome.” When a theory is developed about the topic of interest, researchers develop a hypothesis in the form of “Factor A causes Factor B”. After this hypothesis is formulated, an experiment is then designed to prove or disprove it. While the experiment is conducted, careful measurements or observations should be taken. The experiment is also conducted with all external factors that might affect the results excluded, and only those that would cause a particular outcome included. If it is believed that no other external factor may have influenced the experiment, the researchers can conclude that “Factor A causes Factor B” (Oates, 2006:127).

3.6.3 Design and create

This method of the positivistic research paradigm has the aim of developing new IT products, called 'artefacts', which for Oates (2006:108) make the following contributions to knowledge:

- Constructs – vocabulary for certain concepts in an IT-related domain.
- Models – representations used to aid the understanding of a problem and its associated solution.
- Methods (methodologies) – guidance produced on the products that need to be developed to solve problems using IT.
- Instantiations – a working system that demonstrates that any of the above mentioned methods can be implemented into a computer-based system.

Research using these methods usually involves analysis, design and development of a product which is computer-based, exploring the possibilities of digital technology. For this computer product to be of value to the research it should demonstrate qualities such as analysis, explanation, argument, justification and critical evaluation (academic qualities) aside from the technical skills, but still contribute to knowledge. These contributions can be made through the following three roles which the product plays (Oates, 2006:109):

- as the main focus of the research;
- as the vehicle for something else; or
- as tangible, with focus on the development process.

The 'design and create' method might be the only one by which the product is seen as a contribution to the knowledge, but it may also be used alongside other methods within the overall research methodology. Researchers in Information Systems and Software Engineering are interested in how these artefacts are used in real life, by real people, and therefore 'design and create' methods are used (Oates, 2006:111).

3.6.4 Research method used in this study

The research method used in this study is a survey, the purpose being to gather data from: (1) a large group of people, being IT professionals, project managers, analysts or any other person who might be involved in developing systems, or using or have used any kind of SDM; (2) people representing different organisations, those who develop systems (software houses) and have an ongoing development of their own systems (for example, financial, tertiary, mining, and government); (3) types of projects, being web-based, desktop or mobile; and (4) types of jobs, such as IT professionals, consultants, information systems managers (or heads of IT department or directors of IT), project managers (especially IT projects), developers/programmers, analysts, and others.

Surveys are used to collect data from a large group, but although the gathering is still systematic the data can be generalised to the larger population (Oates, 2006:93). The framework to be constructed should be representative of any type of organisation using an SDM to develop information systems. The use of experiments in this research study was not feasible, as it would require a long time to study the effects of certain actions taken to investigate which SDM would be most suitable. This could be conducted in another research project on the applicability of the framework. Only after the framework has been established and verified can the design and create method be used to automate the framework in providing help to organisations to decide which SDMs will suite them best. The survey method was used as the data was to be gathered from a large number of organisations and individuals.

3.6.4.1 Advantages of surveys

The following advantages of surveys are applicable (Oates, 2006:104):

- Generalised conclusions can be drawn from the representative sample from the wider population.
- Large amounts of data can be collected in a short time, at a reasonably low cost.
- Surveys lend themselves to quantitative data, involving numbers.
- Surveys are known to be repeatable, and similar results will be gathered.

- People with poor inter-personal and communication skills can be reached through the use of postal or Internet surveys.

3.6.4.2 Disadvantages of surveys

There are also disadvantages to the use of surveys (Oates, 2006:105):

- They lack depth when detail is absent from the data.
- They are more focused on quantitative data, and other topics are usually overlooked.
- They illustrate a specific time, that of completion, and not continuous events.
- Assumptions can be made from the data, but no cause and effects can be measured.
- Body language evaluations are not possible when using postal, telephone or Internet surveys.

Despite the disadvantages, the advantage exceed them for this study. It will now be discussed how this research method was used in the research.

3.6.5 Implementation of the research methods in this study

The planning and execution of the survey must be carefully carried out, and can be broken down into the following six activities (Oates, 2006:94), also applying it to the current study:

- 1 Data requirements – determining which data is needed to address and answer the research questions (Oates, 2006:94). From the literature, certain characteristics guided the questions asked to investigate whether they will have an influence on the choice of SDM used. A conceptual model has been constructed in which these characteristics are listed (see Figure 3-2).
- 2 Data generation method – the type of method used to gather the data as described in the first activity (Oates, 2006:95). It was decided to use an electronic, Internet-based questionnaire which was easy to complete, and did not require too much

effort from the respondents to complete. This is also a more cost efficient and practical way to gather data.

- 3 Sampling frame – the list of the population to be included in the study (Oates, 2006:95). A convenient sample was used as it was impossible to obtain a complete list of people employed in IT. People working in software development were used to compile the sampling frame, and who joined at least one of the listed groups on social media (see Annexure C) on a social networking website for professionals, *LinkedIn*. Here the person needed to be listed as one of the active members in the first 25 pages of members (*LinkedIn* does not provide more than 500 members – making up 25 pages).
- 4 Sampling size and technique – deciding how large the sample should be, based on the estimated response rate and taking into account non-respondents, while keeping in mind the technique to be used to choose actual people to participate in the study (Oates, 2006:96,100). A request to complete the questionnaire was posted on IT forums or groups, to which a large number of interested people had subscribed.
- 5 Response rate and non-responses – devising ways of motivating people to participate in the study, as their responses were crucial (Oates, 2006:99).

The response rate has been calculated at 4.27%, as 166 responses were received from a total of 3,886 requests sent out. Schonlau *et al.* (2002) wrote a literature review comparing studies with e-mail-based surveys, and traditional postage surveys. When reporting on the response rate of the former, the lowest response rate was recorded as 5%, with about 80% obtained from a study in which researchers participated (Schonlau *et al.*, 2002:87). The response rate for this study is lower than that reported by Schonlau *et al.* (2002), with a rate of 4.27%, but it is still acceptable.

A covering letter (see Annexure A) accompanied the request for participating in the survey, used to describe the need for this research. The messages have been send out in electronic format, and therefore the letter had to be made available. This was achieved through *DropBox.com*, a web-based communication site onto which the covering letter was uploaded and the link shortened using *Google URL Shortener* (<http://goo.gl/>). This

free service made it possible to track how many people had clicked on the link, and from what platform.

As the research was aimed at specific specialised IT Professionals (3.6.4 above), it was appropriate to post the request to participate in the survey on forums and groups. The message was posted on 15 forums, seven social media (*Facebook*) groups, and 16 *LinkedIn* groups (see list at Annexure C). After about two weeks, it was noted that users were not generally contributing to requests for participation in surveys on groups, with only 19 responses at that time. Personalised messages were therefore sent to as many of the group members as possible, though this was only possible for members of the *LinkedIn* groups, as most of the forums made only certain features available when certain conditions had not been met. *LinkedIn* made only the first 500 members available, from which all connections of the researcher were listed first, limiting the number of members to which the message could be sent without duplication. Another limitation to these first 500 members was that most of the members in a group were recruiting personnel, lowering the number of members. The number of messages sent out has been calculated as 3,139 personalised messages.

E-mails have also been used to send the message to IT Professionals, when the e-mail address was visible to the researcher on *LinkedIn*. Social media has been of great help with the growing the number of people to which this e-mail could be sent. The same message was used to send out the message on *LinkedIn* and by e-mail. It contained both links to the covering letter and questionnaire. The number of personalised e-mails sent out was counted as 747, some of the recipients having indicated that they had sent the request to complete the questionnaire to other interested people (see Annexure A).

3.7 Data collection techniques

A data collection (generation) technique is defined as the means by which the researcher produces empirical (field) data. This can be either quantitative, that is numeric, or qualitative (Oates, 2006:36). The following paragraphs will briefly discuss the types of data collection techniques which could be used with the sample size of this study.

3.7.1 Questionnaires

Oates (2006:219) defines a questionnaire as “a pre-defined set of questions, assembled in a pre-determined order” which could be answered by the respondents. The answers make up the data that is used in this study (Oates, 2006:219). A kind of questionnaire in which the user only ticks the items that are applicable is known as a ‘checklist’, and is part of the experiment method (Blanche *et al.*, 2006:487). The researcher uses the data to identify patterns and to generalise about the actions of the wider population from only a sample (Oates, 2006:219). Questionnaires can be one of two kinds, self-administered, in which the respondent completes the questionnaire alone, and researcher-administered, when the researcher asks the question and writes down the answers down, as in a structured interview (Oates, 2006:219).

3.7.2 Observations

Researchers use observations “to watch” or “to pay attention” to what people actually do, and not what is expected of them (Oates, 2006:202). This includes the behavioural patterns of objects and occurrences without interacting with them (Maree, 2010:83). There are many types of observations that could be made, but the difference between “covert” and “overt” is significant (Oates, 2006:203). In covert research the researcher observes people without informing them. This can be useful because people behave normally, and not as they think is the right way, but the researcher has to be careful not to indicate that they are secretly being observed. Overt research, on the other hand, is when the observed people know that they are being observed by the researcher. Their consent makes this a more ethical method to collect data, but there is a debate about whether people can really give or refuse consent. The researcher have the advantage of being able to move around freely as wanted, and ask as many questions as possible. Because of the nature of human beings, their attitude and behaviour can change for the sake of observation, and this can lead to increased stress because the people think they are doing what the researcher requires (Oates, 2006:204).

3.7.3 Documents

Documents are a possible alternative or supplement to questionnaires, interviews and observations. They can be any symbolic representation to be recorded, and from which analysis can be made once retrieved. Oates (2006:233) lists two types: 'found', which already exist before the research has been conducted, and researcher-generated, which only exist because the research has been undertaken.

3.7.4 Data collection technique used in this study

Questionnaires are best suited for large target groups, and for obtaining standardised, brief data from the respondents with the same questions. Questionnaires should be carefully designed as the respondents should understand the questions, and provide data that is meaningful to the study (Oates, 2006:220). The questionnaire data collection method was used as data had to be gathered from different organisations to identify the patterns between them. These patterns helped in the construction of the framework.

3.7.4.1 Advantages of questionnaires

The following advantages of questionnaires are listed by Oates (2006:229):

- Lower cost than other research methods.
- The more closed questions contained in the questionnaire the easier it is to complete by respondents.
- Geographic locations do not limit the use of questionnaires.
- Self-administrated questionnaires are better for researchers with poor social skills.

3.7.4.2 Disadvantages of questionnaires

The disadvantages of questionnaires are (Oates, 2006:230):

- Closed questions can be biased for the respondents should think the way the researcher thinks.
- The truthfulness of answers are not confirmed.
- Misunderstandings may result in incomplete questionnaires.
- Poor literary skills will limit respondents when using self-administered questionnaires.

The questionnaire as a data collection technique was used despite possible disadvantages, which were considered to be outweighed by the advantages. It would overcome the disadvantages of questionnaires during a thorough pilot test.

3.7.5 Implementation of questionnaires in this study

The questionnaire (see Annexure B) was constructed from the literature sources used in Chapter 2, as well as the theoretical foundation of Rogers (2003) (see Chapter 2, paragraph 2.5). This foundation of Rodgers (2003) also influenced the formulation of certain questions, as well as to guide and categorise them. The questionnaire included all three levels, namely individual characteristics, project characteristics, and organisational characteristics, which might have an influence on the selection of an SDM.

The questionnaire was made available electronically on the Internet, through *Google Forms*, simple and easy-to-use as it had less bandwidth and stored all the responses in the *Google Sheets* format. This could be easily downloaded to *MS Excel*, from where it could be easily imported into software packages for statistical analysis (discussed below at 3.8). A good feature of *Google Forms* is that it enables the user to specify which questions are mandatory, thus limiting the number of questions participants do not answer, as they are not able to continue without first completing the question.

The following aspects have to be considered when a questionnaire is planned and designed (Oates, 2006:221):

- Form of administration – the questionnaire could be self-administered or researcher-administered (as discussed above) (Oates, 2006:221). The questionnaire used in this study was self-administered, as the researcher did not guide the completion and the respondents completed the questionnaire in their own time and at their own pace. With the use of *Google Forms*, the shortened version of the link to the questionnaire could be included in the messages (see above at 3.6.5). This also made it possible to track the platform from which participants were completing the questionnaire, as well as how many people had clicked on the link to see the questionnaire.
- Question content and wording – the questions asked should generate data which can be used to answer the research questions of the study (Oates, 2006:221). Through the use of the pilot study (discussed below at the pre-test and pilot study), the participants generated data which was used to improve the questionnaire, in structure, language, and answers.
- Question types – questions should gather factual data (data that can be verified) and opinions (data representing feelings or other of a respondent). Questions may be open, to which respondents are free to provide their own answer, or closed, from which they choose one of the predefined answers to the specific question (Oates, 2006:222). The questionnaire was constructed with mostly closed-ended questions, from which the participant needed to choose one of the pre-defined answers. On some occasions the participant could choose to provide an alternative to those presented, and adequate space was provided, while trying to understand certain aspects/decisions and why they were made. Only one open-ended question was included (see Annexure B, question 10), for which participants could choose the answer they needed to provide (Oates, 2006:222). Quantitative analysis was used on the data from the questionnaire.
- Format of questions and responses – the type of question and the response formats should complement each other. The correct response format should be used with the correct type of question (Oates, 2006:223). Questions were mostly closed-ended, where the respondent needed to choose an answer from a predefined list of answers. From these questions, most use the Likert scale, defining 5 options (where 1 = “Not

at all”, and 5 = “*To a greater extent*”, or 1 = “*Totally disagree*”, and 5 = “*Totally agree*”). This has been used when a respondent needed to indicate to what degree he/she has agreed or disagreed with some statements.

- Layout and structure – the questionnaire should be laid out clearly and make logical sense. The length of the questionnaire should also be kept in mind (Oates, 2006:226). With using *Google Forms*, the layout of the questionnaire remains the same throughout. The length of each page of the questionnaire was kept short, but there was a concern that the overall questionnaire was slightly long, and that participants might lose interest while completing it. A progress bar at the foot of the page allowed the participant to see how far into the questionnaire they were.
- Pre-test and pilot – it is ideal to pre-test the questionnaire on some respondents to see if the questionnaire is clear and not difficult to use (Oates, 2006:226). The questionnaire was sent out to 10 IT developers to pilot the whole questionnaire, as well as to determine if the questions were clear. These responses were not part of the 166 responses gathered and used in this study. Issues regarding the question wording/language, layout, structure, and the predetermined choices were identified and corrected before verifying the questionnaire again for the final time.
- Validity and reliability – questions should measure what the researcher is researching, using well-balanced questions to be a sample of the domain which needs to be covered (Oates, 2006:227). The validity and reliability of the questions were tested with the use of statistical analysis, discussed in 3.8.1.

The questionnaire was slightly lengthy, as some of the respondents indicated in the comments sent afterwards. Although no space was provided for any comments they felt a need to send messages or e-mails on the importance of the study as well as contributing comments to the study. These comments were also used in the analysis, using qualitative techniques (discussed below in 3.8.2).

Google Forms also provided the facility to print out the form for completion on paper, but had the drawback that one cannot format the form as some headers will appear at the foot of the page and not permit transfer to the following page. Other drawbacks with *Google Forms* are that it has limited functionality regarding the types of questions and formatting the questions for uniformity throughout and spacing within questions. Some of

these issues are visible in Annexure B, especially questions 3.4 and 3.6, for example. In the past, the confirmation page automatically had a link to guide the respondent to complete another questionnaire, which may lead to incorrect or skew data. This has been changed so that the researcher has the option to turn off this feature, only thanking the respondents and not inviting them to another round to complete the questionnaire. Despite the drawbacks, it was successfully used to gather necessary data.

Each group or forum had its own *Google Form* questionnaire, by which the link of each questionnaire was shortened using the *Google URL Shortener*. This link made it possible to record the number of clicks on the URL to the questionnaire, as well as the number of responses gathered from each group or forum. It was also possible to track how many of the recipients had responded to the e-mail or message, had read the covering letter and accessed the questionnaire. This does not necessarily mean the recipient had completed the questionnaire (see Annexure A for the number of clicks made in these messages, divided per group/forum, to the questionnaire, as well as how many people visited the covering letter).

3.7.5.1 Questions

The following figure (Figure 3-2) is a conceptual model for the construction and interpretation of the questionnaire. The numbers in parenthesis represent the question numbers as they appear in the questionnaire (Annexure B).

Adoption Unit

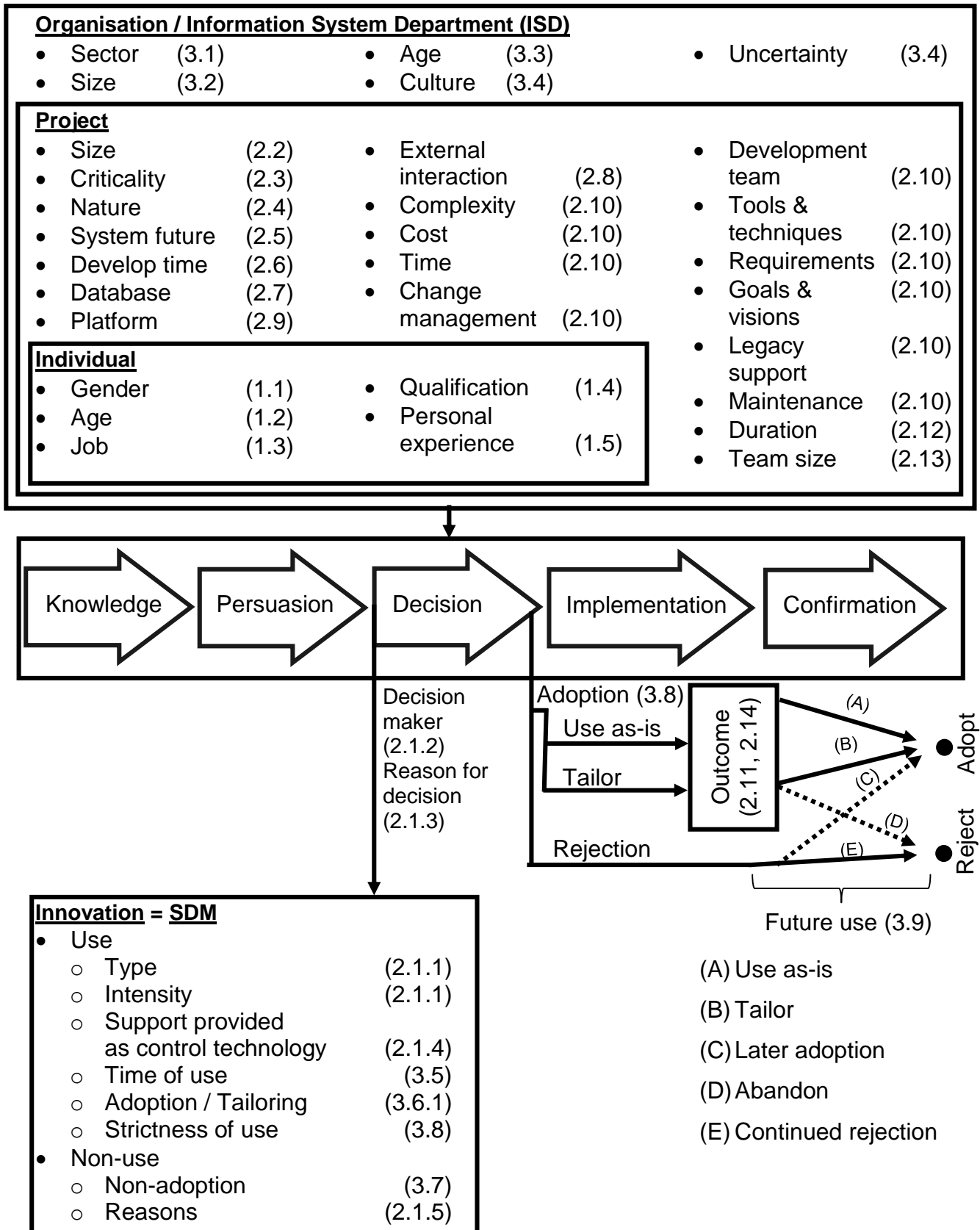


Figure 3-2: Conceptual model of the questionnaire

Table 3-1 displays the composition of the questionnaire. References are included from the sources of literature in which the variables have been identified. As stated above, the use of a theoretical foundation made some questions necessary.

Table 3-1: Composition of questionnaire

Variables	No of items	Reference
Section A – Individual		
1.1 Gender	1 item	
1.2 Age	1 item	
1.3 Job Category	1 item	Nkone (2013)
1.4 Qualification	1 item	Nkone (2013)
1.5 Personal Experience in SD	1 item	Nkone (2013); Vavpotic <i>et al.</i> (2004); Vavpotič & Vasilecas (2012)
Section B – Project		
2.1 SDM Usage	3 items	
SDM Choice	1 item	
2.2 Project Size	1 item	Dyck & Majchrzak (2012); Mnkandla & Dwolatzky (2007); Nkone (2013); Sheffield <i>et al.</i> (2011); Vavpotic & Krisper (2004)
2.3 Project Criticality	1 item	Dyck & Majchrzak (2012); Sheffield <i>et al.</i> (2011); Vavpotič & Vasilecas (2012)
2.4 Project Nature	1 item	Vavpotič & Vasilecas (2012)
2.5 Planned System Future	1 item	Vavpotič & Vasilecas (2012)
2.6 Project / Development Time	1 item	Cockburn (2000); Mnkandla & Dwolatzky (2007)
2.7 External Database (DB) Interaction	1 item	Vavpotič & Vasilecas (2012)
2.8 External Systems Interaction	1 item	Vavpotič & Vasilecas (2012)
2.9 Platform of System Developed	1 item	Vavpotic & Krisper (2004); Vavpotič & Vasilecas (2012)
2.10.1 Problem Complexity	3 items	Clara (2013); Dyck & Majchrzak (2012); Lemétayer (2010); Mnkandla & Dwolatzky (2007)
2.10.2 Project Cost Limitations	2 items	

Variables	No of items	Reference
Section B – Project (cont.)		
2.10.3 Project Time Limitations	2 items	
2.10.4 Change Management	3 items	Burns & Dennis (1985); Dyck & Majchrzak (2012); Lemétayer (2010); Mandal & Pal (2013)
2.10.5 Development Team	4 items	Clara (2013); Dyck & Majchrzak (2012); Klopper <i>et al.</i> (2007); Ruiz (2009); Sheffield <i>et al.</i> (2011); Vavpotic <i>et al.</i> (2004)
2.10.6 Tools and Techniques	2 items	Klopper <i>et al.</i> (2007); Nkone (2013)
2.10.7 Requirements	3 items	Clara (2013); Dyck & Majchrzak (2012); Mnkandla & Dwolatzky (2007); Nkone (2013); Sheffield <i>et al.</i> (2011)
2.10.8 Goals and Vision	3 items	Nkone (2013)
2.10.9 Legacy Support	3 items	Vavpotič & Vasilecas (2012)
2.10.10 Maintenance	1 item	Dyck & Majchrzak (2012); Ruiz (2009)
2.11 Project Outcome	17 items	Nkone (2013)
2.12 Project Duration	1 item	
2.13 Team Size	1 item	
2.14 Usability of the System	11 items	Mandal & Pal (2013)
Part C – Organisational / Information Systems Department (ISD)		
3.1 Organisation Sector	1 item	Nkone (2013)
3.2 Organisation/ISD Size	1 item	Nkone (2013)
3.3 Organisation/ISD Age	1 item	
3.4 Organisation Culture	14 items	Huisman (2000, 2013)
3.5 Methodology Usage Time	1 item	Dyck & Majchrzak (2012); Ruiz (2009)
3.6 SDM Tailoring	2 items	
3.7 Adoption of SDMs	3 items	Nkone (2013)
3.8 Strictness of SDM Usage	1 item	Wagener (2012)
3.9 Future Usage of Chosen SDM	1 item	

3.8 Data analysis

Data analysis is the use of techniques to find patterns and relationships, and to draw conclusions (Oates, 2006:245). It may vary according to the types of data collected, as well as the research paradigm used. Both quantitative and qualitative data analysis will be discussed next, as will the advantages and disadvantages of each.

3.8.1 Quantitative data analysis

“Numbers are meaningless unless we analyse and interpret them in order to reveal the truth that lies beneath them.” (Leedy & Ormrod, 2005:253)

Quantitative data is used to make sense of the world, using numbers to represent certain phenomena and is usually associated with positivist research. Quantitative data analysis is used to make numeric data more meaningful by identifying patterns in the data and drawing conclusions from understanding the interrelationships present. Statistics may be used to interpret these numbers as statistics are a means whereby computational procedures allow people to find patterns and meaning in numerical data (Leedy & Ormrod, 2005:253; Oates, 2006:245).

3.8.1.1 Frequencies

Frequencies are another way of stating how many respondents chose a specific answer to a question, whether by a simple frequency distribution, or a grouped frequency distribution. The simple frequency distribution is the reporting of the number of respondents who have selected a specific answer. The grouped frequency distribution is used when some answers are grouped together, and the number of respondents who chose an answer in that group are reported (Bertram & Christiansen, 2014:141; De Vos *et al.*, 2011:255; Maree, 2010:184).

This statistical technique was used in this study to represent how many respondents chose a specific answer to the questions.

3.8.1.2 Mean and Standard deviation

The mean (\bar{x}) is a statistical measurement of central tendency used to summarise the data. This value (the mean) is a *hypothetical* number, as it will not necessarily represent a data value which is observed in the data. The mean can be calculated as the sum of the data values, divided by the number of data values (Field, 2009:22, 35):

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

where n is the number of data values, and x_i the data values which are added together. The mean is usually also referred to as the *average*.

The standard deviation (s) is the estimate of the mean spread of a set of data, usually measured in the same unit as the original data (Field, 2009:37). The standard deviation is the average measure (in the same unit) of how much the data deviate from the mean (average) (Bertram & Christiansen, 2014:158). The formula used to calculate the standard deviation, is as follows:

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

Here, n is the number of data values, and \bar{x} is the mean (explained above). This statistical technique has been used together with the mean statistic to indicate how the answers from respondents differed.

3.8.1.3 Factor analysis

Factor analysis is the grouping of items that measure the same component (factor) (Maree, 2010:219) or latent variables (Field, 2009:629). These items would have been measured using a scale (the Likert-scale, for instance), and all respondent have answered them in a similar manner (Maree, 2010:219). Factor analysis reduces a data set of interrelated items to a group of factors, making large datasets easier to interpret (Field, 2009:629).

The Principal Component Analysis (PCA) is a sound procedure commonly used in factor analysis because it is less complex than original factor analysis, as is concerned with the establishment of linear components and how they contribute to the overall component (Field, 2009:638).

To obtain the number of factors to extract, the eigenvalues are used. These are known to be the loading of an item on a factor, all starting at one (all items contribute to the factor equally). The Kaiser Criterion states that all items with a large (more than one) eigenvalue should be retained as factors. Each represents the variance that is explained by that particular linear component. Field (2009:641) makes the argument that the criteria of Kaiser are too strict, but states the evidence is available that the Kaiser Criterion is accurate when less than 30 items are used (as is the case in this study), and all the communalities extracted are greater than 0.7 (Field, 2009:640-641, 660-662).

Using the Kaiser Criterion for factor analysis will result in most of the items loading highly onto the first factor, and the rest will have small loadings onto the other factors. Factor rotation is used to discriminate between the identified factors. Two types of rotation exist (Field, 2009:642):

- 1 Orthogonal (unrelated) rotation. All factors are independent before the rotation, ensuring that the factors remain independent (to not correlate) during the rotation (Field, 2009:642).
- 2 Oblique rotation. Allows the factors to correlate while rotating (Field, 2009:642).

Figure 3-3 (below) illustrates the difference between orthogonal and oblique rotation. The diagram on the left illustrates the orthogonal rotation and that on the right the oblique rotation.

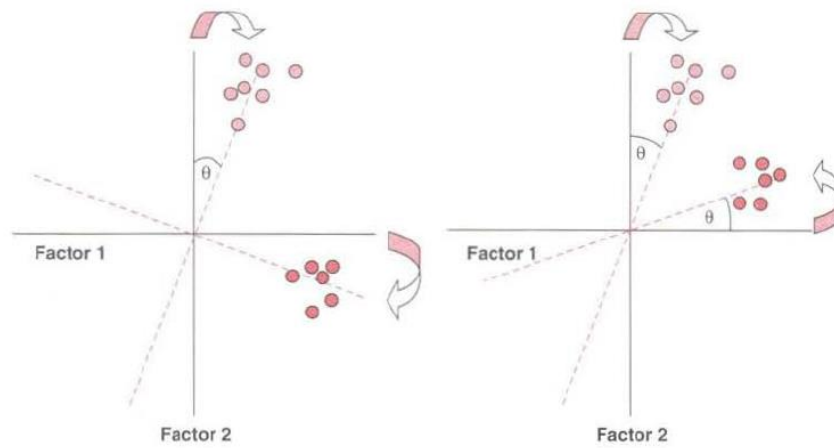


Figure 3-3: Difference between orthogonal and oblique rotation (Field, 2009:643)

In this study, the factors were allowed to correlate, and therefore the oblique rotation technique was used in SPSS to extract the rotations and to produce a pattern matrix, which contains the factors loading, or the unique contribution of the item to the factor (Field, 2009:666-667). The pattern matrix was used to identify the items which loaded onto the different factors.

In this study, factor analysis was performed mainly on those questions for which the Likert scale had been used to answer the question. When one question consisted of more than two variables, factor analysis was performed to determine if the number of variables could be reduced for this study.

3.8.1.4 Cronbach alpha reliability

The Cronbach Alpha (α) is the most common measure of reliability used for scales. It has been an improvement of the split-half reliability test, when the data is divided into halves. A score is then calculated for each half, where the two scores should be the same (or similar) in each of the two halves, and should correlate very highly). The Cronbach Alpha takes another step to calculate the average of the two scores, and could be used to measure the score reliability (Field, 2009:674). The following formula could be used to calculate the Cronbach α :

$$\alpha = \frac{N^2 \overline{Cov}}{\sum s_{item}^2 + \sum Cov_{item}}$$

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where N is the number of items (which are squared), \overline{Cov} is the average covariance calculated between items, s^2 is the variance (which are summed) and the Cov is the covariance of an item (which are summed).

The value of α will be between 0 and 1, where the closer the value is to 1, the higher the reliability usually is (De Vos *et al.*, 2011:177). Maree (2010:216) proposes the following general guideline to be used with Cronbach Alpha:

- $\alpha \geq 0.9$ – high reliability
- $\alpha \geq 0.8$ – moderate reliability
- $\alpha \geq 0.7$ – low reliability

Field (2009:675) argues that the structure of the scale has an influence on the value of α which should be considered. If two scales are different both can yield the same value for α , but these values should then be interpreted according to the scale. Huisman (2000:65) concluded that reliability of at least 0.6 should be used with exploratory research in SDMs due to a lack of empirical research. This value will be used in this research as the cut-off value where values below 0.5 are unacceptable.

In this study, the Cronbach α statistical technique has been used together with the factor analysis explained above.

3.8.1.5 Correlation

Correlation is the measure of the strength of the linear relationship between two variables (Maree, 2010:234). Effect sizes (explained in section 3.8.1.6) is one of the means to measure correlations.

While explaining correlations, Field (2009:170) explains the use of the Pearson's correlation coefficient, which delivers a standardised value to be used. The correlation coefficient (r) can be calculated as follows:

$$r = \frac{cov_{xy}}{s_x s_y} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{(N - 1)s_x s_y}$$

where cov_{xy} is the covariance of variables x and y , s_x is the standard deviation of variable x , and s_y is the standard deviation of variable y . More of the meaning and interpretation of this correlation coefficient can be found in section 3.8.1.6.

In this study, Spearman's correlation coefficient (Spearman's rho, r_s) is used. This test first ranks the data, after which the Pearson's equation (r stated above) is applied to the ranks. Spearman's rho is usually used if data violates the parametric assumptions, such as the non-normally distributed data, making it a non-parametric statistic. This statistical technique has been used with all the variables, investigating how each variable related to any others.

3.8.1.6 Effect sizes

Effect sizes are a standardised (objective) measure, scale-free, for measuring the magnitude of the difference or the correlation (Field, 2009:56; Maree, 2010:210). This measure is not affected by the size of the sample as that would influence the statistical significance which may be calculated. Effect sizes could be compared across multiple studies, as this is possible with the standardised measure (Field, 2009:56; Maree, 2010:211). Effect sizes are helpful in many cases, for instance, when the difference between two means and the relationship between variables are the most important cases. Many measures exist, such as Cohen's d , Pearson's correlation coefficient r as well as the odds ratio. Researchers do not all use the same measure, as one may prefer one of the abovementioned. Field (2009) prefer the Pearson's correlation coefficient, while Maree (2010) prefer Cohen's d . Ellis and Steyn (2003:51) states that different effect sizes are applicable to different analysis. Taking all effect sizes into account used in this study (as well as those mentioned above), the following table suggests guidelines for the use of these measures:

Table 3-2: Guidelines for interpreting effect sizes

d	f^2	R^2	r	ω	Meaning
0.2	< 0.15	< 0.15	0.1	0.1	Small practical effect
0.5	0.15—0.35	0.15—0.35	0.3	0.3	Medium practical effect
0.8	>0.35	>0.35	0.5	0.5	Large practical effect

The value of some measurements must lie between -1 and +1, but effect sizes of more than 1 are possible (Ellis & Steyn, 2003:51). A value of 0 indicates that no effect exists, and a 1 indicates that a perfect effect exists. When the values are +1, there exists a perfect positive effect, meaning that as the value of one variable increases, the second variable increases by a proportionate amount. The opposite effect could be observed with a value of -1 (a perfect negative effect), meaning that as one variable increases, the other variable decreases by a proportionate amount (Blanche *et al.*, 2006:206; Field, 2009:170; Leedy & Ormrod, 2005:273).

It should be noted that the above mentioned effect sizes are not measured on a linear scale. Therefore, we cannot say that 0.6 is twice as big as 0.3 (Field, 2009:57). The values reported in Table 3-2 is not cut-off values, but one should interpret the values where they lie between the values. For example, 0.53 should not be interpreted as a large practical effect, but rather as a medium practical effect as this value is in the region of 0.5 (Maree, 2010:212). In this study, this statistical technique has been used together with the ANOVA analysis performed.

The following formulas could be used to calculate the effect sizes. For Cohens d when measuring the difference between means (Ellis & Steyn, 2003:51):

For use with t-tests:

$$d = \frac{|\bar{x}_1 - \bar{x}_2|}{s}$$

where \bar{x}_i is the mean for sample i , and s is the pooled standard deviation from the samples.

For the use with ANOVA:

$$d = \frac{|\bar{x}_i - \bar{x}_j|}{\sqrt{MSE}}$$

where \bar{x}_i is the mean for sample i , and MSE is the mean square error of analysis of variance.

The omega effect size can also be used with the ANOVA analysis, using

$$\omega = \frac{SS_M - (df_M)MS_R}{SS_T + MS_R}$$

where SS_M is the sum of squares between groups, SS_R is the sum of squares within groups, SS_T is the sum of squares total, df_M is the degree of freedom between groups, and MS_R is the mean squares within groups.

For regression analysis:

$$f^2 = \frac{R^2}{1 - R^2}$$

where R^2 is the coefficient of determination and is usually provided by regression analysis.

For calculating the Pearson's r , refer to section 3.8.1.5 for calculating the correlation coefficient. When calculating Pearson's r with t -tests, the following formula could be used (the values are read from the t -test output):

$$r = \sqrt{\frac{t^2}{t^2 - df}}$$

3.8.1.7 Regression

Regression is the next step after correlation. It is known that a relationship exists between variables, as regression predict one variable from another. Regression analysis is thus defined as the way to predict an outcome variable (dependant variable) from a predictor variable (independent variable). Using one predictor variable is known as simple regression, and using more than one predictor variable is known as multiple regression (Field, 2009:198; Leedy & Ormrod, 2005:282; Maree, 2010:240). This statistical technique has been used in the study where the variables were continuous, mainly after factor analysis had been performed.

3.8.1.7.1 Simple regression

The simple regression method is based on the straight line on a mathematical scatter plot. Regression analysis has the purpose of determining the “best” straight line through the points on the scatter plot. The equation of the “best” line through these points could be denoted as:

$$Y = a + bX$$

where Y is the dependant variable (the outcome) and X is the independent variable (only one as the case is with simple regression), a (or α) is the intercept where the line crosses the Y-axis, b (or β) is the magnitude of the relationship between the dependant and independent variable. Once these values are substituted into the equation, one can predict the dependant variable when substituting X as the value of the independent variable (Maree, 2010:240).

The coefficient of determination is the measure of the “closeness” of the points to the straight line. This is denoted as r^2 and interpreted as “the amount of the total variation in Y that is explained by X ” (Maree, 2010:241).

3.8.1.7.2 Multiple regression

Multiple regression differs from simple regression in that not only one independent variable (X) is used, but more than one (X_1, X_2 , etc.). This model uses numerical scale variables. The equation stated above will be adapted to the following equation:

$$Y = a + b_1X_1 + b_2X_2 + \dots + b_kX_k$$

where k is the number of independent variables, Y is the dependant variable (the outcome) and X_i is the independent variable, a (or α) is the intercept where the line crosses the Y-axis, b (or β) is the magnitude of the relationship between the dependant and it's corresponding independent variable (Maree, 2010:242-243).

3.8.1.8 t-Tests

The t-test is a versatile statistic as it can be determined if the means between two groups are different. The following two types of t-tests exist (Field, 2009:325):

- Dependent-means *t*-test – this test is usually used when the same participants were involved, but two different conditions existed and the participants took part in both (Field, 2009:325).
- Independent-means *t*-test – this test is usually used where two different conditions exist, and different participants were involved in both (Field, 2009:325).

In this study, the independent-means t-test have been used. This is looking for differences between the groups, therefore they are divided with the standard deviation of differences between the groups (Field, 2009:334). The *t*-value is calculated by the following formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}\right)}}$$

where \bar{X}_i is the mean for the particular population, $\frac{s_i^2}{N_i}$ is the variance of population *i*, and the standard error of the sampling distribution of differences is noted as $\sqrt{\left(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}\right)}$. This equation is to be used with sample sizes that are equal.

The formula is adapted when using sample sizes that are not equal:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}\right)}}$$

where

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

This formula makes it clear that t-tests could be computed when the data is not available, only the means, standard deviations and sample sizes are needed (Field, 2009:336). This

statistical technique has been used in this study with variables relating to the goals of this study, studying where differences may exist based on the use of an SDM for the development or when no SDM are used.

3.8.1.9 ANOVA

Field (2009:349) explains the ANOVA (analysis of variance) as the combination of conducting many t-tests. The problem here is that the change to make a Type I error (the probability of falsely rejecting the null hypothesis) increases significantly, so that it is not acceptable to scientists. As the t-test tests the hypothesis that two variables have the same means, the ANOVA analysis test if three or more variables have the same mean. One of the disadvantages of the ANOVA is that it can indicate if the means of the three variables are the same, but if not where the difference lies, or whether any means are the same.

This statistical technique has been used in this study where more than two of the variables were compared to investigate if there is any relationship between three variables.

3.8.1.10 Advantages of quantitative data analysis

Oates (2006:263) states the following advantages of quantitative data analysis:

- Scientific respectability.
- Well-established techniques and methods are used.
- The results can be verified by other people.
- Software programmes analyse large volumes of data quickly.

3.8.1.11 Disadvantages of quantitative data analysis

Analysis of quantitative data also has some disadvantages (Oates, 2006:263):

- Working with numbers frightens some people.
- Using software, many people may not understand the results properly.
- The tests on the data are only as good as the data gathered.
- The methods and techniques used should be carefully chosen and stated.
- Objectivity is still a problem as the researcher has a choice of many ways to present that data.

3.8.2 Qualitative data analysis

“Qualitative data includes all non-numeric data – word, images, sounds, and so on...”
(Leedy & Ormrod, 2005:266)

Qualitative data is mostly material that is very rich in relation to the context. It will, however, lose some of its meaning when broken down into bits, as with quantitative data (Blanche *et al.*, 2006:286). The questionnaire had one open question for which respondents needed to explain why a certain SDM had been chosen. It was not possible to analyse this question quantitatively, therefore some qualitative techniques were used. These responses were analysed to obtain a clear explanation as to why certain SDMs had been chosen in their respective organisations.

Although the questionnaire had not requested any comments from the participants, some felt the need to reply to the request for completing the questionnaire by e-mail. All of these responses are included in the analysis as some contain information regarding the research conducted, as well as some recommendations for future research.

The e-mails from the respondents have been labelled as E1 through to E38, and the messages received on *LinkedIn* M1 through to M84. They have been analysed using the coding technique, and will be briefly discussed in the following chapter.

3.9 Summary

This chapter has presented the research design, with all four dimensions addressed. These four dimensions are the purpose, context, paradigm and techniques. The purpose and context have been discussed, linked to the context in which the research was conducted. The positivistic research paradigm was used for conducting a survey using a questionnaire to collect data. It was discussed how *Google Forms* was used for the collection of the data, which was then statistically analysed using various methods, including factor analysis, regressions, correlations, and ANOVA. These results will be stated and discussed in the following chapters.

CHAPTER 4

DESCRIPTION OF PARTICIPANTS INCLUDED IN SAMPLE

4.1 INTRODUCTION

Chapter 3 described the research methodology used, as well as the manner of collecting and interpreting the data. The results that have been collected and analysed will now be stated. The background information will first be reported, followed by component (factor) analysis where applicable, followed by reliability analysis. The reporting will follow the conceptual model, first reporting on the individual, then the project, and lastly on the organisation or Information Systems Department (ISD). Chapter 5 to 8 will be used to discuss and report on the analysis made to answer the objectives of this study (see Chapter 1, section 1.3).

The conceptual model is illustrated in Figure 4-1, and the flow diagram in Figure 4-2 illustrates the flow of the questionnaire and how the respondents were navigated through the questionnaire to answer the relevant questions.

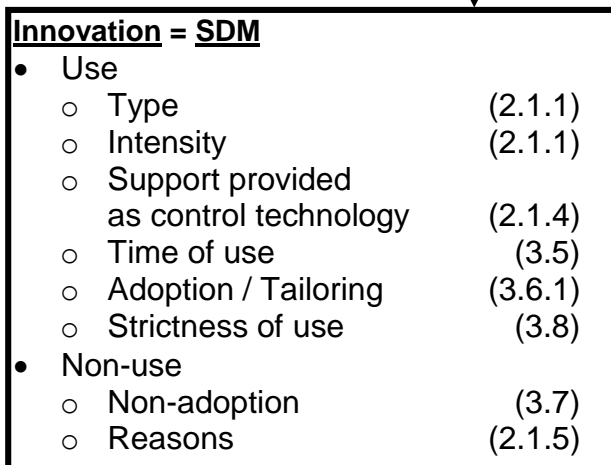
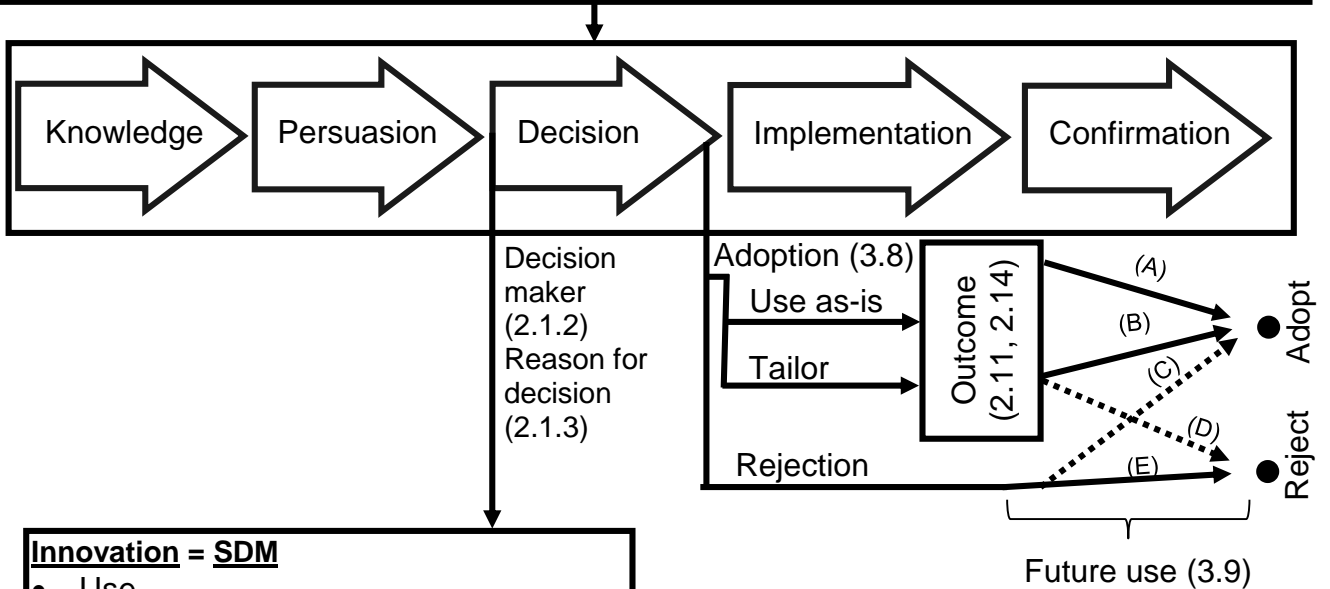
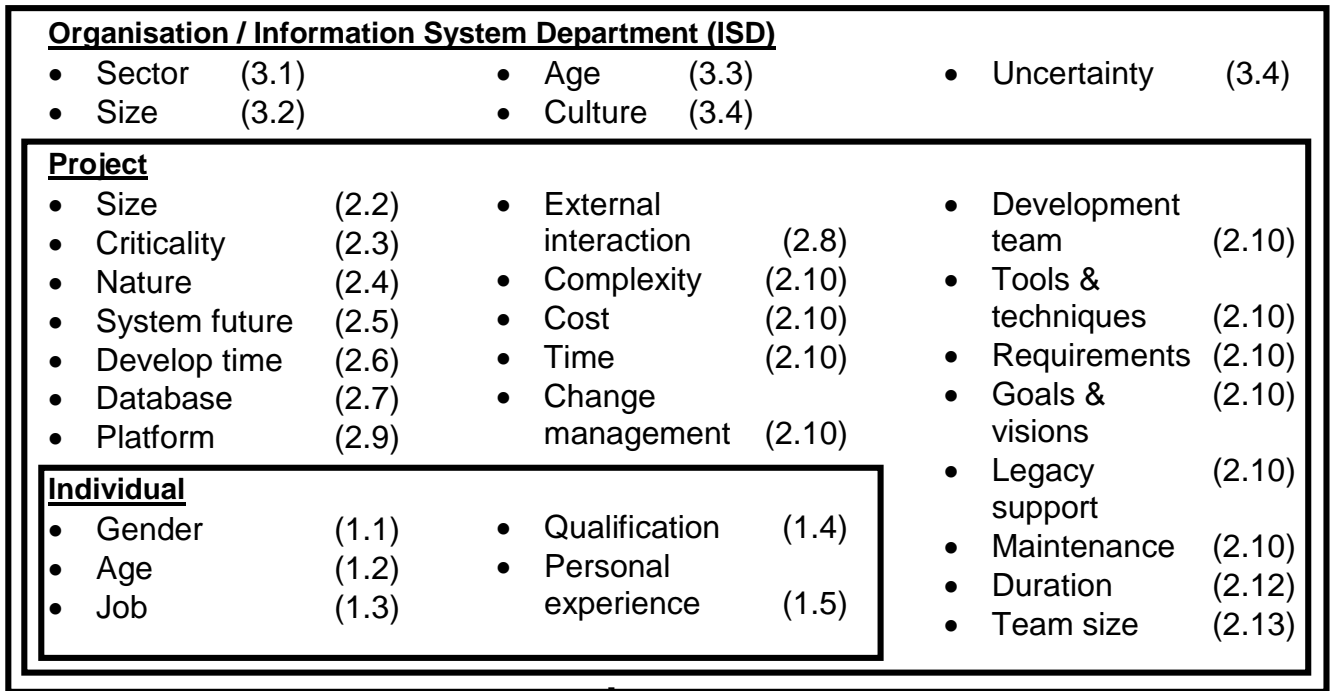
4.2 RESPONSE RATE

From the 3,886 requests sent out for completing the questionnaire and participating in this study, only 166 responses were collected, a 4.27% response rate.

4.3 SECTION A: BACKGROUND OF THE PARTICIPANTS

Five questions were asked to gather background information about the individuals, forming one of the levels that influence the selection of an SDM, namely gender, age, job category, highest qualification and personal experience, to be discussed below.

Adoption Unit



- (A) Use as-is
- (B) Tailor
- (C) Later adoption
- (D) Abandon
- (E) Continued rejection

Figure 4-1: Conceptual model of the questionnaire

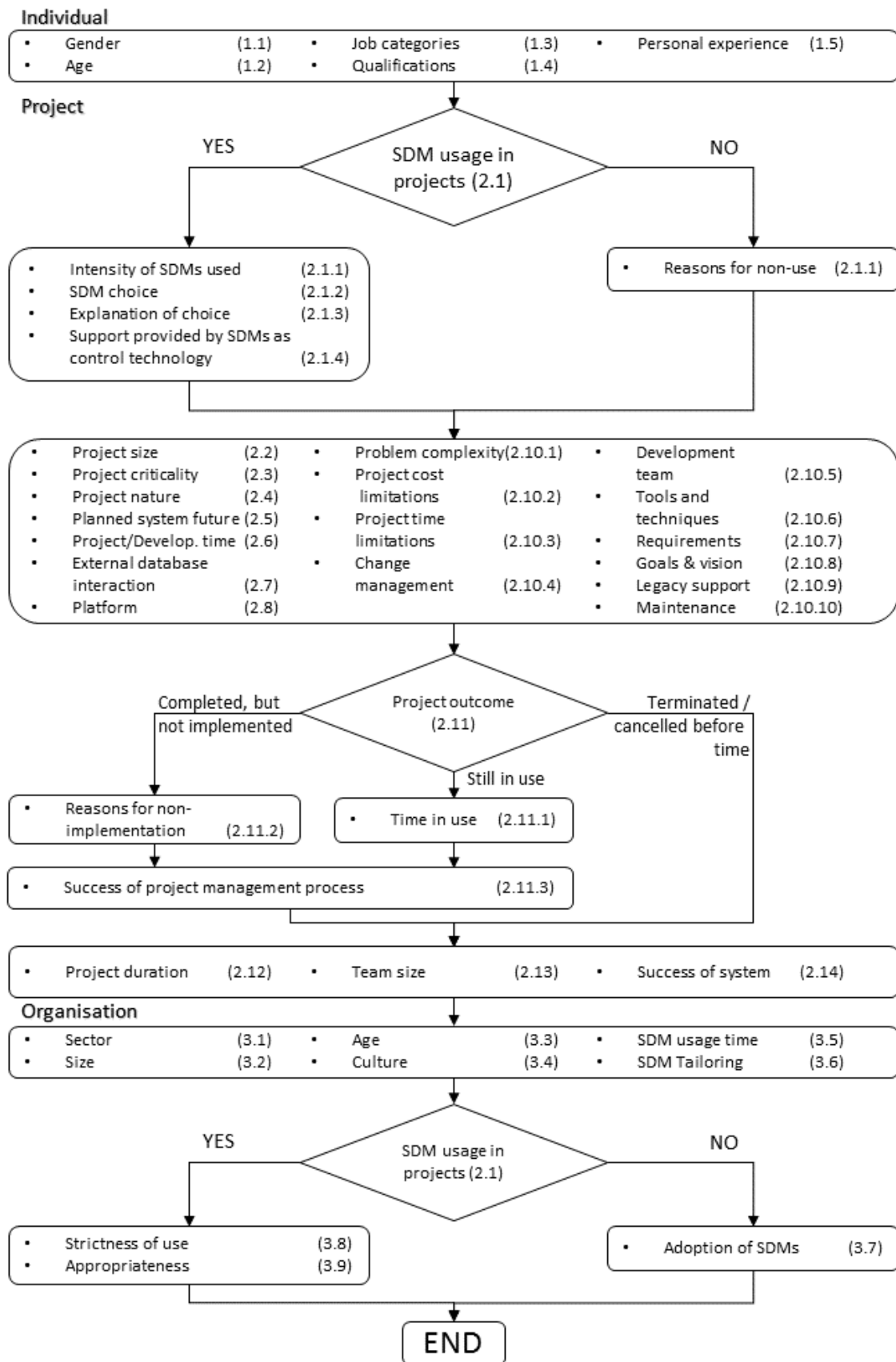


Figure 4-2: Flow diagram of the questionnaire

4.3.1 Gender

Most of the respondents were males (87.3%), leaving 12.7% females.

4.3.2 Age

Respondents had to choose their age from five groups of predefined intervals. No respondents were 18 years or younger, so this interval is excluded from the results in Table 4-1. Most were of the younger generation with ages between 26 and 35, with 70% of all respondents 35 or younger.

Table 4-1: Percentage of ages of respondents

Job category	N	Percentage	Cumulative percentage
19 – 25	36	22%	22%
26 – 35	80	48%	70%
36 – 45	37	22%	92%
46 or older	13	8%	100.0%

4.3.3 Job category and qualifications

The following table represents the percentage of job categories the participants indicated. The developers/programmers were represented with 61% of all the respondents, being actively involved with the development of the systems.

Table 4-2: Percentage of job categories

Job category	N	Percentage	Cumulative percentage
Information System Manager	16	10%	10%
Project Manager / Leader	25	15%	25%
Developer / Programmer	101	61%	86%
Analyst	7	4%	90%
Other job categories	17	10%	100%

From all the responses, only about 5% had a senior certificate (Matric) as the highest qualification. Only one of these did not complete high school, where the highest grade passed was Grade 8.

Table 4-3: Highest qualifications obtained

Highest qualification	N	Percentage	Cumulative percentage
Other (Grade 8)	1	1%	1%
Senior certificate (Matric)	7	4%	5%
Certificate / Diploma	33	20%	25%
University / Technicon degree	51	31%	56%
Honours degree	37	22%	78%
Master's degree	35	21%	99%
Doctoral degree	2	1%	100%

Table 4-3 indicated that the data was distributed in such a manner that 75% of the respondents had at least a university or Technicon degree.

4.3.4 Personal experience in systems development

The following table illustrates the distribution regarding the personal experience of respondents in systems development.

Table 4-4: Personal experience of respondents in systems development

Personal experience	N	Percentage	Cumulative percentage
None	3	2%	2%
Less than 1 year	1	1%	3%
1 year or more – less than 2 years	19	11%	14%
2 years or more – less than 5 years	44	27%	41%
5 years or more – less than 10 years	39	23%	64%
10 or more years	60	36%	100%

From Table 4-4 it can be seen that slightly fewer than 60% of all respondents had five years or more experience in the development of systems. The first three items of this question have been grouped together to form an item stating 'no to less than 2 years' of experience. This was done because the frequencies in these three groups were too low to be used further in this manner.

The rest of this chapter will be divided into the two sections corresponding to the layout of the questionnaire. Firstly, the background information of the project will be discussed, then divided into parts illustrating projects which did not use SDMs and those which did. The last section will be devoted to the background information of the organisation.

4.4 SECTION B: BACKGROUND INFORMATION OF THE PROJECTS REPORTED IN THE SURVEY

To the first question of the part regarding the project the participants had to indicate if they have used an SDM in the latest project. From all the responses, 81% indicated having used an SDM, while 19% had not used any. Of significance, the male programmer who listed Grade 8 as the highest qualification indicated not having used any SDM in the latest project.

4.4.1 Intensity of SDMs used

On a scale of 1 to 10, respondents had to choose how intensely they were using the SDMs provided. The figure 1 indicated "*not at all*" and 10 indicated *very intensely*. Table 4-5 illustrates the number of responses on each of these SDMs, as well as the mean and standard deviation of the answers. The list has been sorted from the highest mean to the lowest.

Table 4-5: Descriptive statistics: SDMs used according to the intensity of usage

N=134	Mean	Std. Dev.	Percentage of frequency									
			1	2	3	4	5	6	7	8	9	10
Scrum	7.0	3.3	18.7	0	1.5	4.5	2.2	5.2	6.7	13.4	17.2	30.6
SDLC	6.3	3.0	16.4	0.7	3.0	5.2	9.0	8.2	13.4	19.4	10.1	14.2
RAD	4.7	3.5	38.8	2.2	4.5	4.5	5.2	4.5	10.4	10.4	9.0	10.4
UML	3.9	3.0	38.1	4.5	12.7	5.2	11.9	3.0	8.2	6.0	6.7	3.7
STRADIS	3.8	3.1	45.5	4.5	3.7	6.7	10.4	2.2	7.5	9.7	3.7	6.0
XP	3.8	3.2	48.5	2.2	5.2	5.2	6.7	7.5	4.5	7.5	7.5	5.2
WSDM	3.1	3.0	61.2	2.2	0.7	3.7	10.4	1.5	6.0	6.7	3.7	3.7
SSADM	3.1	3.0	61.2	1.5	3.7	4.5	4.5	3.0	6.7	7.5	3.7	3.7
IE	2.8	2.9	65.7	2.2	4.5	3.0	3.7	4.5	5.2	3.0	3.7	4.5
OO-HDM	2.5	2.8	71.6	2.2	2.2	1.5	1.5	6.7	4.5	3.7	3.0	3.0
SSM	2.2	2.3	73.1	0.7	5.2	3.0	3.7	5.2	3.0	3.7	0.7	1.5
OMT	2.2	2.4	76.1	1.5	2.2	1.5	6.0	3.7	1.5	3.0	3.0	1.5
Other	2.2	2.8	81.3	0.7	0.7	0.7	2.2	0.7	2.2	2.2	3.7	5.2
HDM	2.0	2.2	78.4	2.2	3.0	0	2.2	6.0	3.7	3.7	0	0.7
YSM	1.7	1.8	82.8	3.7	3.0	2.2	0.7	3.0	1.5	1.5	0	1.5
LBMS	1.6	1.8	83.6	3.7	3.0	1.5	0.7	3.0	1.5	1.5	0.7	0.7
JSD	1.6	1.7	83.6	2.2	3.7	1.5	3.7	1.5	0.7	1.5	0.7	0.7
Merise	1.6	1.7	85.1	4.5	2.2	0	1.5	3.7	0.7	0.7	0.7	0.7

A principal component analysis (PCA) was conducted on the 18 items in Table 4-5 (above), with oblique rotation (oblimin). The Kaiser-Meyer-Olkin (KMO) measure verified the sampling adequacy for this analysis, $KMO = 0.937$, which are classified as *superb* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (153) = 2685.806$, $p < 0.001$ tested whether the correlations between the items were sufficiently high. After the initial analysis was run to obtain the eigenvalues for each component in the data, three components had eigenvalues of more than one, according to the Kaiser Criterion, explaining a combined total of 70.98% of the total variance.

The initial Cronbach alpha has been calculated for the above-mentioned three components. This reliability on component one indicated that excluding one of the items would increase the reliability of the component. This item (Scrum) has been extracted

and considered as the fourth component. The final reliability for the components has been determined and reported in Table 4-6.

The final component structure included four components, of which component 1 represents the intensity of more familiar SDMs used, component 2 represents the intensity of unfamiliar SDMs used, component 3 represents the intensity of other, in-house developed SDMs the respondents provided, and component 4 represents the intensity of Scrum.

Table 4-6: Final component structure: Intensity of SDM usage

Intensity of SDMs used (F0)	Intensity of more familiar SDMs (F1)	Intensity of unfamiliar SDMs (F2)	Intensity of other, in-house SDMs (F3)	Intensity of Scrum (F4)
All items	Rapid application development (RAD)	Merise	Other	Scrum
	Structured Analysis, Design and Implementation of Information Systems (STRADIS)	Yourdon Systems Method (YSM)		
	System Development Life Cycle (SDLC)	LBMS system development method		
	Web site design method (WSDM)	Jackson Systems Development (JSD)		
	Extreme Programming (XP)	Object Modelling Technique by Rumbaugh (OMT)		
	Structured Systems Analysis and Design Method (SSADM)	Hypermedia design method (HDM)		
	Information Engineering (IE)	Soft Systems Methodology (SSM)		

	Unified Modelling Language (UML)			
	Object oriented hypermedia design method (OO-HDM)			
Cronbach α	0.874	0.943	-	-
Mean	3.78	1.86	1.77	5.64

The means of each of the components had been calculated and presented at the foot of Table 4-6, indicating that component four (intensity of Scrum) had the highest mean (with 5.64), followed by component one (intensity of more familiar SDMs) with a mean of 3.78.

4.4.2 Choice and motivation of SDM

Four alternatives were presented to choose from (Information system manager (ISM), Project manager, Developers and Analyst) regarding who made the choice of the SDM to be used. Participants could choose from one of these alternatives, but could also choose more than one, as well as providing other options for decision-making groups.

Table 4-7: Combinations of people involved in the decision-making process

Combinations	N	Percentage	Cumulative percentage
ISM	23	13.9%	13.9%
ISM, Project manager	8	4.8%	18.7%
ISM, Project manager, Developers	6	3.6%	22.3%
ISM, Project manager, Developers, Analyst	5	3.0%	25.3%
ISM, Developers	5	3.0%	28.3%
ISM, Developers, Analyst	2	1.2%	29.5%
Project manager	23	13.9%	43.4%
Project manager, Developers	16	9.6%	53.0%
Project manager, Developers, Analyst	4	2.4%	55.4%
Project manager, Analyst	2	1.2%	56.6%
Developers	23	13.9%	70.5%

Developers, Analyst	2	1.2%	71.7%
Analyst	4	2.4%	74.1%
Other	43	25.9%	100%

Figure 4-3 has been constructed to indicate the decrease in number of people involved in the decision of which SDM to use. The data was derived from Table 4-7 (above), and “other” responses have been added to the number of groups, including all the groups the respondents indicated.

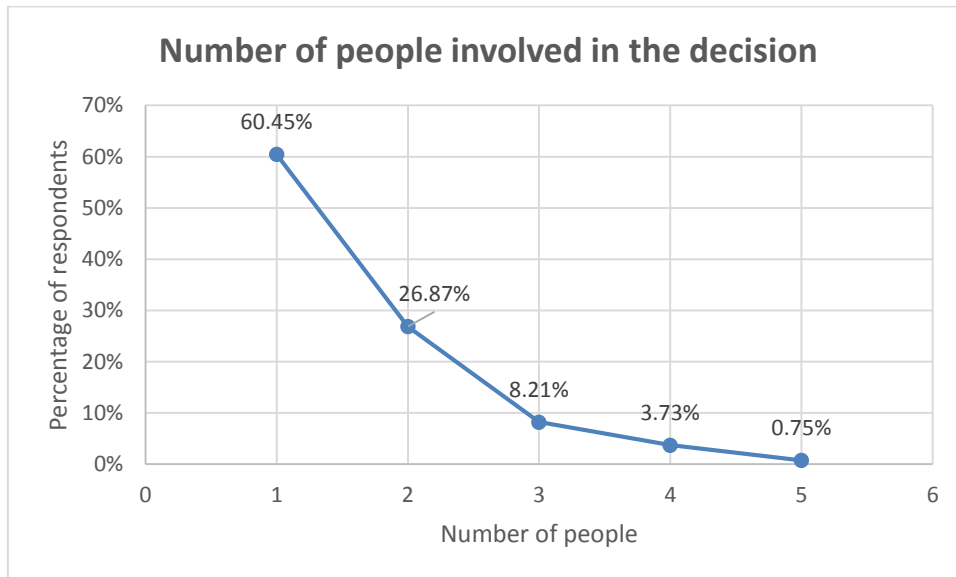


Figure 4-3: Illustration indicating the decrease in decision groups involved

Most of the group labelled as “other” indicated by respondents indicated that Architects and System Engineers made some contribution to the choice of SDM. From the figure, it is evident that there was usually only one person involved in deciding which SDM to use. From the responses, in only one organisation there were five people involved in the decision.

Respondents also provided comments as to the motivation of choice of the certain SDM(s). The comments were labelled C1 through to C133, and the following themes were identified in these comments using the qualitative coding technique. Table 4-8 indicates the list of themes, the frequency, as well as the numbers of the comments in which the theme(s) was/were present.

Table 4-8: Themes identified from the reasons for using SDM(s)

No	Theme	Freq	Comments
1	Organisation involvement	16	C6, C8, C15, C17, C31, C34, C35, C49, C50, C58, C76, C83, C84, C85, C100, C106
2	Quick development	13	C7, C9, C15, C22, C30, C47, C50, C53, C59, C87, C112, C113, C114
3	Use of tailored SDM	11	C32, C55, C63, C69, C80, C82, C88, C93, C94, C96, C97
4	Buzzword/go with the flow	8	C21, C42, C48, C55, C57, C63, C71, C92
5	Environment	7	C1, C2, C5, C106, C110, C120
6	Accommodating changes	7	C2, C3, C19, C44, C89, C114, C132
7	Change of requirements	6	C11, C43, C46, C59, C102, C131
8	Lack of knowledge	6	C21, C57, C68, C75, C110, C112

The themes above can be explained as follows:

- 1 Organisation involvement – The respondents who indicated that the organisation had been involved in some manner in the choice also stated that the size, policies, preferences, nature of the business and culture had directed their choice of which SDM to use.
- 2 Quick development – Respondents indicated that the choice of SDM had been based on the need for rapid development, releasing software faster, and quick delivery or time to market.
- 3 Use of tailored SDM – Some organisations had developed their own SDM to use, or combined some approaches through the years to find an appropriate SDM to work for them.
- 4 Buzzword/go with the flow – A number of respondents indicated that their choice of SDM was based on the buzzword at that moment, or had made the choice to “go with the flow”.
- 5 Environment – Seven respondents indicated that the environment in which they worked had directed the choice of which SDM to use.

- 6 Accommodating changes – Flexibility and the accommodation of changes throughout the development had been the driving factor behind what SDM to use for some respondents.
- 7 Change or requirements – The SDM the respondents had chosen was based on the accommodation of the rapid changes in requirements evident in the development of systems.
- 8 Lack of knowledge – Some respondents indicated that a lack of knowledge existed about SDMs, and therefore one was just chosen (mostly by going with the flow or the buzzword at that time) and used.

Other themes that were picked up included the acceptance of the client, client satisfaction, size and type of the project, type of development, size of the organisation, sector/industry and culture of the organisation, as well as increase in productivity of the organisation. The frequency of these themes was low and therefore excluded from the table above.

4.4.3 Non-use of SDMs

This following section will discuss why SDMs were not used by those who indicated not having used an SDM in the latest project (19%). This paragraph will be based on reasons an SDM had not been used. This question was measured on a five point Likert-scale, with which the figure 1 represented “*Not at all*” and 5 “*To a greater extent*”.

Table 4-9: Descriptive statistics: Reasons for non-use of SDMs

N=32	Mean	Std. Dev.
The adoption and use of SDMs are long-term, whereas the limitations on cost and time are short-term.	3.6	1.0
No clear objectives exists for the adoption of SDMs in the IS department.	3.6	1.1
The need for the use of an SDM has been reduced by the experience and expertise of the developers in the IS department.	3.5	1.2

SDMs are not adopted in the IS department as there is lack of commitment from top management.	3.5	1.2
Uncertainty regarding the benefits of SDMs are present in the IS department.	3.5	1.2
The IS department does not adopt an SDM due to the lack of experienced staff.	3.4	1.3
The financial investment for adopting SDMs is too high.	3.0	1.3
The environment within the IS department is not suited for the use of SDMs.	2.9	1.2
The SDM currently in use in the IS department is adequate.	2.8	1.1
The profile of IS department does not require the use of an SDM.	2.7	1.2
The adoption and following of SDMs are too complex and too hard to use.	2.7	1.0
The learning curve for SDMs is too long.	2.5	1.1

A PCA was conducted on the 12 items in Table 4-9 (above) with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, KMO = 0.565, which is classified as *mediocre* (Field, 2009:659), which is still acceptable with the cut-off at 0.5. Bartlett's test of sphericity $\chi^2 (66) = 162.050$, $p < 0.001$ tested that the correlations between the items were sufficiently high. After the initial analysis was run to obtain the eigenvalues for each component in the data, four components had eigenvalues of more than one, according to the Kaiser Criterion. These four components explained a combined total of 72.24% of the total variance. These four components were retained, where component one represents the non-supporting environment, component two the lack of experience, component 3 uncertainty, and component 4 long-term commitment.

All the Cronbach α were above the minimum of 0.5 (Field, 2009:675), where components 1 and 3 (non-supporting environment and uncertainty) had a moderate reliability, where the lack of experience and long-term commitment (components 2 and 4) had low reliabilities. These reliabilities are presented at the foot of Table 4-10, together with the eigenvalues for each of these components converged after 31 iterations.

Table 4-10: Final component structure: Reasons for the non-use of SDMs

Reasons for non-use (F0)	Environment not supporting (F1)	Lack of experience (F2)	Uncertainty (F3)	Long-term commitment (F4)
All items	The SDM currently in use in the IS department are adequate .	The IS department does not adopt an SDM due to the lack of experienced staff .	No clear objectives exists for the adoption of SDMs in the IS department.	The adoption and use of SDMs are long-term , whereas the limitations on cost and time are short-term.
	The profile of IS department does not require the use of an SDM.	The learning curve for SDMs is too long .	Uncertainty regarding the benefits of SDMs are present in the IS department.	SDMs are not adopted in the IS department as they lack commitment from top management .
	The need for the use of an SDM has been reduced by the experience and expertise of the developers in the IS department.		The environment within the IS department are not suited for the use of SDMs.	
	The financial investment for adopting SDMs is too high .		The adoption and following of SDMs are too complex and too hard to use .	
Eigenvalues	2.869	2.471	2.739	1.437
Cronbach α	0.753	0.622	0.695	0.554
Mean	3.00	2.95	3.16	3.55

The mean of the responses has been calculated based on the components constructed, where the long-term commitments could be classified as the most important component with an average of 3.55 (out of 5). The mean values are presented at the foot of Table 4-10 (above).

4.4.4 Usage of SDMs

The following sections will analyse the 81% of respondents who had used an SDM in the last development project.

4.4.4.1 Perceived support provided by SDMs as control technology

As the respondents indicated that they had used an SDM in the latest project. The first question was to determine the support the SDM provided as control technology. This question consisted of nine items, with a Likert scale where 1 = *Totally disagree*, and 5 = *Totally agree*. Table 4-11 provides the frequencies for these items.

Table 4-11: Descriptive statistics: Perceived support provided by SDMs as control technology

N=132	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The system development methodology helps to decompose the system to be developed in workable parts.	4.21	0.92	1.5	2.3	18.2	29.5	48.5
Overall, the system development methodology helps us to manage our systems development projects.	4.14	0.91	2.3	1.5	17.4	37.9	40.9
The system development methodology helps in defining useful milestones for the systems development projects.	4.12	0.96	0.8	7.6	12.9	36.4	42.4
The system development methodology helps to plan systems development projects.	4.06	0.91	1.5	4.5	15.2	43.9	34.8
The system development methodology helps to organise system development projects.	4.05	0.86	1.5	3.0	15.9	47.7	31.8
The system development methodology helps to estimate the size of the system to be developed.	3.81	1.16	5.3	9.1	18.9	32.6	34.1
The system development methodology helps to estimate the	3.77	1.10	3.8	9.8	22.0	34.8	29.5

time and effort required for the development of a planned system.							
The system development methodology helps to keep the systems development projects under control.	3.71	1.08	4.5	7.6	26.5	34.8	26.5
The systems development methodology helps to estimate the project risks.	3.42	1.12	4.5	16.7	30.3	28.8	19.7

A PCA was conducted on these nine items with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, $KMO = 0.868$, which is classified as *great* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (36) = 488.754, p < 0.001$ tested that the correlations between the items were sufficiently high. After the initial analysis was run to obtain the eigenvalues for each component in the data, only two components had eigenvalues of more than one, according to the Kaiser Criterion. These two components explained a combined total of 60.84% of the total variance. These two components were retained, where component 1 represents the control of the SDM as Project Management and component 2 the decomposition of the developed system.

All the Cronbach α were above the minimum of 0.5 (Field, 2009:675), where component one had a high reliability, $\alpha = 0.808$. These reliabilities are presented at the foot of Table 4-12, together with the sample size (N), the average (\bar{x}) and the standard deviation (s) for all the items. The eigenvalues at the bottom of the table are converged after seven iterations.

Table 4-12: Final component structure: Perceived support provided by SDM as control technology

Support provided by SDMs as control technology (F0)	SDM control as Project Management (F1)	Decomposition of system development (F2)
All items	The SDM helps to keep the systems development projects under control .	The SDM helps to decompose the system to be developed in workable parts.
	The SDM helps in defining useful milestones for the systems development projects.	The SDM helps to organise system development projects.

	Overall, the SDM helps us to manage our systems development projects.	The SDM helps to estimate the size of the system to be developed.
	The systems development methodology helps to estimate the project risks .	The SDM helps to estimate the time and effort required for the development of a planned system.
	The SDM helps to plan systems development projects.	
Eigenvalues	3.884	3.278
Cronbach α	0.808	0.796
Mean	3.89	3.96

The mean of the responses have been calculated based on the components constructed, and reported at the foot of Table 4-12. Both components report a similar mean of response, suggesting that both components are almost of equal importance.

4.4.4.2 Project size, criticality, nature, future and development time

The following tables present the statistics and frequencies regarding the following five characteristics: Project size (Table 4-13), project criticality (Table 4-14), project nature (Table 4-15), planned system future (Table 4-16), and project/development time (Table 4-17).

Table 4-13: Descriptive statistics: Project size

	N	Percentage	Cumulative percentage
Small	23	13.9%	13.9%
Medium	59	35.5%	49.4%
Large	57	34.3%	83.7%
Very large	27	16.3%	100%

It could be noted that almost half of all the projects were considered as large projects. More than half (35.5%) of the other 50% of the projects were considered as medium-sized projects.

Table 4-14: Descriptive statistics: Project criticality

	N	Percentage	Cumulative percentage
System failure can result in a loss of comfort.	21	12.7%	12.7%
System failure can result in a loss of discretionary money.	46	27.7%	40.4%
System failure can result in a loss of essential money.	85	51.2%	91.6%
System failure can result in a loss of life.	14	8.4%	100%

The importance of these systems is evident in Table 4-14. More than half indicated that if the system were to fail the organisation would have a loss of essential money. Slightly over 8% believed that a loss of life would be the result if the system failed. These 8% may be systems used in the Healthcare / Hospitality / Medical sector (discussed at 4.5.1).

Table 4-15: Descriptive statistics: Project nature

	N	Percentage	Cumulative percentage
New development.	76	45.8%	45.8%
Upgrade from previous development (the current system is only updated).	53	31.9%	77.7%
Complete improvement from previous development (system is completely done over).	37	22.3%	100%

Almost half (45.8%) of the systems developed in this questionnaire were seen as new, which means the organisations would get new systems to perform tasks previously done by hand, or which had not been carried out in the organisation.

Table 4-16: Descriptive statistics: Planned system future

	N	Percentage	Cumulative percentage
Maintenance only	22	13.3%	13.3%
Minor upgrades	56	33.7%	47.0%
Major upgrades	48	28.9%	75.9%
New versions based on this version	40	24.1%	100%

When looking at the planned future of the systems developed, it could be noted that more than 60% of all the systems would only undergo some upgrades, either minor or major. Almost a quarter would be developed in versions, where the current system in development has only been part of one version.

Table 4-17: Descriptive statistics: Project development time

	N	Percentage	Cumulative percentage
Less than 1 year	78	47.0%	47.0%
1 year or more – less than 2 years	55	33.1%	80.1%
2 years or more – less than 5 years	25	15.1%	95.2%
5 or more years.	8	4.8%	100%

Although approximately half of the systems had been classified as a large project, Table 4-17 indicates that only about 5% of all the projects had a development time of five or more years to completion. Just under half (47%) of all the projects had a short development time of less than one year to complete the development of the system.

4.4.4.3 Interaction of the database and external systems

With most of the systems developed as web-applications, the following table illustrates the interaction of these systems, as well as the others, with the databases mentioned. Table 4-18 describes the frequencies and other statistics for the interaction of the systems with types of databases, with a Likert scale where 1 = *Totally disagree*, and 5 = *Totally agree*.. The “relational database” is seen as the more popular database to be used with systems today.

Table 4-18: Descriptive statistics: Systems interaction with database types

N=166	Mean	Std. Dev.	Percentage of frequency			
			1	2	3	4
Relational database	3.35	1.02	10.8	7.8	16.9	64.5
Network database	2.54	1.35	38.6	8.4	13.9	39.2
Data warehouse	2.23	1.25	44.6	10.8	21.1	23.5
Object-oriented database	2.09	1.20	48.2	13.9	18.7	19.3
Object-relational database	1.99	1.13	49.4	16.9	19.3	14.5
Hierarchal database	1.80	1.06	57.2	17.5	13.9	11.4

As systems not only interact with a database, a question was asked regarding the number of external systems with which the developed system had to interact. This would then increase the complexity, as the standards and formats of the other systems need also to be considered. Only 7.2% of all systems did not interact with any external system, with 39.7% interacting with only one or two external systems. The remaining 60.3% interacted with three or more external systems.

4.4.4.4 Platform of the developed systems

With new technology continuously emerging, the percentage of desktop systems being developed has dropped to about 22.3% whilst the number of web-based applications has increased (68.1%). Mobile telephone applications are still relatively recent, with only 9.6% of the projects in this study having been involved in developing mobile applications in the latest projects.

4.4.4.5 Description of the project characteristics between non-use and use of SDM

A set of questions have been asked regarding the project in which the most recent system has been developed. These questions appear as the complete section 2.10 in the questionnaire, with the questions categorised under certain themes. Table 4-19 presents descriptive statistics for both the set of respondents who have not used an SDM (non-use of SDM), opposed to those who have, in the latest development project (discussed

at 4.4). These questions were measured on a five point Likert-scale, with figure 1 representing *Not at all* and 5 *To a greater extent*.

Table 4-19: Difference between SDM use and non-use on project characteristics

N=166	Use of SDM (N=134)		Non-use of SDM (N=32)	
	\bar{x}	<i>s</i>	\bar{x}	<i>s</i>
Problem complexity				
The project recognised the level of complexity of the system.	3.93	1.04	3.56	0.91
The system developed was of a complex nature.	4.09	0.89	3.94	0.76
The problem complexity was very high.	3.61	1.07	3.41	0.95
Project cost limitations				
Cost limitations were present in the budget for the development of the system.	3.34	1.34	2.78	1.43
Limitations on the cost of the system suppressed the development of the system.	2.71	1.35	2.44	1.37
Project time limitations				
Adequate time has been given for the development of the system.	3.39	1.19	3.19	1.15
The time assigned to each task had been enough.	3.23	1.13	2.72	1.30
Change management				
Changes requested to the system developed were managed effectively.	3.53	1.22	3.13	1.18
Unexpected crises and deviations were present in the development.	3.53	1.17	3.44	1.29
The unexpected crises and deviations were managed effectively.	3.71	1.07	3.56	1.01
Development team				
The development team had high experience in the use of the chosen SDM.	3.70	1.12	2.94	1.11
The project team was very cooperative during development.	4.20	0.94	3.97	0.82
The team was not distributed over the country/world when the systems were developed.	2.65	1.61	2.53	1.59

Team members never communicated through technology while busy developing.	3.84	1.38	3.22	1.39
Tools and techniques				
Appropriate development tools (CASE tools) were used for development.	3.60	1.31	3.03	1.31
Appropriate development techniques were used.	4.13	0.96	3.78	1.07
Requirements				
Users changed the requirements of the system regularly during the project.	3.40	1.24	3.59	1.32
The requirements from users were understandable to the developers.	3.84	0.92	3.63	1.13
Conflicting user requirements were present during the project.	3.12	1.23	3.25	1.34
Goals and vision				
Clear goals were set before and were evident during the development.	3.88	1.04	3.34	1.45
A clear vision and clear objectives were present on the project..	3.90	1.08	3.56	1.32
The goals and vision were mutually agreed upon.	3.90	1.05	3.41	1.46
Legacy support				
The system involved technologies with which the developers were familiar.	4.07	1.03	3.81	1.23
The development team had high levels of expertise in development.	4.16	0.96	3.75	1.11
When knowledge lacked, training was given to gain the appropriate knowledge.	3.31	1.33	2.59	1.36
Maintenance				
The developed system included a well-defined maintenance plan.	3.42	1.31	2.91	1.35

4.4.4.6 Project outcome

Asked to indicate the outcome of their project, only 1% of the respondents said it had been cancelled or terminated before time, 8.4% completed but not implemented or the system was no longer in use. Most systems had been completed, implemented, and were still in use (90.4%).

Of the 90.4% of respondents who indicated an implemented system still in use, they also indicated the number of months these systems were in use. Figure 4-4 indicates the cumulative number of months the systems were in use. More than half had only been in use for less than one year, whereas only 3% of all the systems had been in use for more than six years.

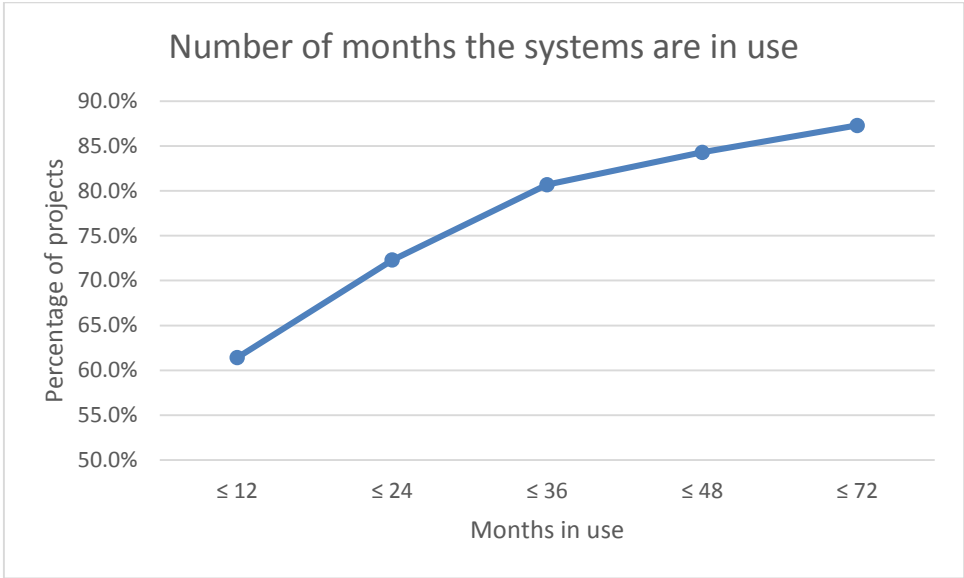


Figure 4-4: Cumulative percentage of system usage time

The longest reported system had been in use for about 41 years and 8 months (at the time the data was collected). Of significance, a combination of SDMs was used from the well-known SDMs for this particular project. The system were also in use in a transportation or communication organisation, when the team size involved in the development was between eight to 15 people.

4.4.4.7 Reasons for not implementing the developed system

When respondents indicated that the project had been completed but not implemented, or no longer in use, they had to answer two questions regarding the implementation or installation process. These questions were measured on a Likert scale by which 1 indicated *Not at all* and 5 *To a greater extent*.

Table 4-20: Descriptive statistics: Reasons for non-implementation

N=166	Mean	Std. Dev.	Percentage of frequency			
			1	2	3	4
The project had a well-planned installation and adoption of the developed system in user departments.	2.50	1.29	35.7%	7.1%	28.6%	28.6%
The project had timely provision of comprehensive control information at each stage of the implementation process.	3.00	0.96	7.1%	21.4%	35.7%	35.7%

The percentage of the Likert-scale of 5 indicated *To a greater extent* had not been included in the table above, as no respondents indicated to agree to a greater extent with one of these statements. From the table above, it can be derived that users felt that not all the projects had a well-planned implementation process, but that each stage of the implementation had provided them with comprehensive control information.

4.4.4.8 Success of project management process

One of the subsections in section B of the questionnaire gathered data regarding the success of the support the SDM provided as a project management process, labelled as “Project outcome”. This subsection consisted of 11 items, with a Likert scale where 1 = *Not at all*, and 5 = *To a greater extent*. The first four questions were reduced to only two items, reducing them for the PCA to nine. This question had only been answered by the respondents who had indicated having completed the last development project (98.8%). Table 4-21 provides the descriptive statistics for this item.

Table 4-21: Descriptive statistics: Success of the project management process

N=132	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The overall status of the project is that the project was a success.	4.27	0.95	1.2	6.0	9.6	31.3	51.8
The system developed achieved the goal for which the system was first intended.	4.23	0.91	1.2	4.8	10.2	36.7	47.0
The developed system satisfied all the requirements stated.	4.05	0.96	1.8	6.0	13.9	41.6	36.7
The project overall represents excellent work done.	4.03	1.01	2.4	6.0	16.3	36.7	38.6
The project had high productivity.	3.81	1.02	2.4	8.4	22.9	38.0	28.3
The speed at which new applications were developed was high.	3.78	1.08	4.2	8.4	20.5	38.6	28.3
Cost regarding the development of the system was low when compared to the size and the complexity of the system developed.	3.42	1.15	6.6	13.9	29.5	30.7	19.3
The project was completed before/on schedule.	2.86	1.16	30.1	12.3	13.9	28.7	15.0
The project was completed within/under budget.	2.78	1.06	27.1	12.3	30.4	15.4	14.8

A PCA was conducted on these nine items with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, KMO = 0.888, which is classified as *great* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (55) = 877.206, p < 0.001$ tested that the correlations between the items were sufficiently high. After the initial analysis was run to obtain the eigenvalues for each component in the data, only two components had eigenvalues of more than one, according to the Kaiser Criterion. These two components explained a combined total of 60.84% of the total variance and were retained, where component 1 represents the project management process and component 2 high efficient process. Table 4-22 represents the final component structure.

Table 4-22: Final component structure: Success of project management process

Success of project management process (F0)	Project management process (F1)	High efficient process (F2)
All items	The project overall represents excellent work done.	The project was completed within/under budget.
	The overall status of the project is that the project was a success.	The project was completed on/before schedule.
	The system developed achieved the goal the system was first intended for.	
	The project had high productivity.	
	The developed system satisfied all the requirements stated.	
	The speed at which new applications were developed was high.	
	Cost regarding the development of the system is low when compared to the size and the complexity of the system developed.	
Cronbach α	0.879	0.767
Mean	3.94	2.82

The mean of the responses has been calculated based on the components constructed, indicating that the project management process (component one) is of greater importance with a mean response of 3.94. The means are reported at the foot of Table 4-22.

4.4.4.9 Project duration and team size

Respondents had two questions regarding the duration of the project and the size of the team who worked on it. The following two tables provide the descriptive statistics regarding the project duration (Table 4-23) and the team size (Table 4-24).

Table 4-23: Descriptive statistics: Project duration

	N	Percentage	Cumulative percentage
Less than 1 year	85	51.2%	51.2%
1 year or more – less than 2 years	50	30.1%	81.3%
2 years or more – less than 5 years	22	13.3%	94.6%
5 or more years.	9	5.4%	100%

Although approximately half of the systems have been classified as a large project, more than half only had a duration of less than one year. More than 80% of all projects had a duration of less than two years.

Table 4-24: Descriptive statistics: Team size

	N	Percentage	Cumulative percentage
Less than 7 people	97	58.4%	48.4%
8 – 15 people	47	28.3%	86.7%
16 – 25 people	8	4.8%	91.5%
26 or more people	14	8.4%	99.9%

From the teams to develop the systems, more than half consisted of fewer than seven people, whilst almost 90% of the teams comprised 15 or fewer.

4.4.4.10 Success of the system developed

Eleven questions were asked regarding the system that had been developed. The question was aimed at determining how useful the system was, and how successful they regarded it. All 11 items had a Likert scale from 1, *Totally disagree*, to 5, *Totally agree*, presented in Table 4-25.

Table 4-25: Descriptive statistics: Success of the system developed

N=166	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The functionality of the developed system is high.	4.32	0.77	11.2	0.6	9.6	42.2	46.4
The developed system meets the user needs.	4.23	0.78	0.6	1.8	12.7	44.0	41.0
Overall, the developed system is a success.	4.21	0.90	1.8	3.0	12.0	38.6	44.6
The reliability of the developed system is high.	4.15	0.84	1.2	1.8	16.3	42.2	38.6
The usability of the developed system is high.	4.11	0.86	0.6	3.0	19.3	38.6	38.6
Overall, the quality of the developed system is high.	4.10	0.86	1.2	3.6	14.5	45.8	34.9
Overall, the users are satisfied with the developed system.	4.10	0.86	0.6	3.6	18.1	41.0	36.7
The efficiency of the developed system is high.	4.05	0.86	0	5.4	18.1	42.8	33.7
The maintainability of the developed system is high.	4.04	0.91	0.6	6.0	18.1	39.8	35.5
The portability of the developed system is high.	3.68	1.15	6.6	9.0	20.5	37.3	26.5
The documentation of the developed system is good.	3.10	1.29	13.9	21.1	22.3	27.1	15.7

A PCA was conducted on the 11 items with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, $KMO = 0.912$, which is classified as *superb* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (55) = 1082.661$, $p < 0.001$ tested that the correlations between the items were sufficiently high. An initial analysis was run to obtain the eigenvalues for each component in the data, and two components had eigenvalues of more than one, according to the Kaiser Criterion. These two components explained a combined total of 66.12% of the total variance.

All the Cronbach α were above the minimum of 0.5 (Field, 2009:675), where component 1 had a high reliability, $\alpha = 0.926$, and the second component had a low reliability, $\alpha = 0.572$. This second component has been divided to use the two items separately.

Three components were retained, by which component 1 represents the success of the system, component 2 its portability, and component 3 the documentation. These reliabilities are presented at the bottom of Table 4-26, together with the Cronbach α for components 1 after four iterations.

Table 4-26: Final component structure: Success of the system/product

Success of system/product (F0)	Success of the system (F1)	Portability of the system (F2)	Documentation of the system (F3)
All items	The reliability of the developed system is high.	The portability of the developed system is high .	The documentation of the developed system is good .
	The developed system meets the user needs .		
	Overall, the developed system is a success .		
	The functionality of the developed system is high .		
	Overall, the users are satisfied with the developed system.		
	The usability of the developed system is high .		
	Overall, the quality of the developed system is high .		
	The maintainability of the developed system is high .		
	The efficiency of the developed system is high .		
Cronbach α	0.926	-	-
Mean	4.14	3.68	3.10

The means of the responses were calculated based on the components constructed, and presented at the foot of Table 4-26. The success of the system (component 1) had the highest mean, indicated to be the most important of the three components. This has been closely followed by the portability of the system (component two) with a mean of 3.68 (out of five).

4.5 SECTION C: BACKGROUND INFORMATION ON THE ORGANISATION / INFORMATION SYSTEMS DEPARTMENT

The following section presents the data analysis for the organisation, or the Information Systems Department (ISD). This is the third level of adoption to be involved in the choice of SDM.

4.5.1 Organisation sector

The first question in Section 3 of the questionnaire aimed at determining in what kind of sector the organisations fell. Table 4-27 shows the responses recorded. Where respondents chose the “*other*” option, it was noted that healthcare / hospitality / medical were frequently mentioned, and is therefore indicated as a separate sector.

Two categories, electricity and water supply, and Community services are not included in the table above as no companies fell within them.

4.5.2 Size, age and culture of the organisation

Respondents had to choose how many employees was part of the organisation, choosing from a list of predetermined scales. The descriptive statistics for the size of the organisations are presented in Table 4-28.

Table 4-27: Descriptive statistics: Organisational sectors

	N	Percentage	Cumulative percentage
System Development	47	28.3%	28.3%
Financial / Banking	39	23.5%	51.8%
Other	34	20.6%	72.4%
Consulting	12	7.2%	79.6%
Transport and communication	8	4.8%	84.4%
Healthcare / Hospitality / Medical	8	4.8%	89.2%
Computer vendor	7	4.2%	93.4%
Manufacturing	4	2.4%	95.8%
Mining	3	1.8%	97.6%
Government	3	1.8%	99.4%
Tertiary sector	1	0.6%	100%

Table 4-28: Descriptive statistics: Organisational size

	N	Percentage	Cumulative percentage
Less than 10 employees	24	14.5%	15.5%
11 – 100 employees	60	36.1%	50.6%
101 – 500 employees	30	18.1%	68.7%
501 – 2000 employees	25	15.1%	83.7%
2001 or more employees	27	16.3%	100%

Most of the organisations had between 11 and 100 employees in service, with just more than half having up to 100 employees at the time of the research.

Seven categories were presented for the age of the organisation, as respondents had to choose only one category. Table 4-29 presents these descriptive statistics.

Table 4-29: Descriptive statistics: Organisational age

	N	Percentage	Cumulative percentage
Less than 5 years	15	9.0%	9.0%
5 years or more – less than 10 years	34	20.5%	29.5%
10 years or more – less than 15 years	39	23.5%	53.0%
15 years or more – less than 20 years	22	13.3%	66.3%
20 years or more – less than 25 years	11	6.6%	72.9%
25 years or more – less than 30 years	8	4.8%	77.7%
30 or more years	37	22.3%	100%

Most of the organisations had been in business for between 10 and 15 years, followed by those that had been in business for more than 30 years. More than half had existed for less than 15 years (53%).

The competing values framework (Huisman, 2000, 2003) had been provided and used to determine the culture within each of the organisation of the respondents. This framework measures four cultures, which are group, developmental, hierarchical and rational. Each culture had three questions, which have been grouped together to form components.

The following table provides the descriptive statistics of the 12 individual items as they were presented in the questionnaire.

Table 4-30: Descriptive statistics: Organisational culture

N=166	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The IS department I work in, is a very personal place. It is like an extended family and people seem to share a lot of themselves. (Group)	3.7	1.1	5.4	9.0	24.7	34.9	25.9
The IS department I work in, is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks. (Developmental)	3.5	1.1	3.6	13.9	30.1	32.5	19.9
The IS department I work in is a very formal and structured place. People pay attention to bureaucratic	2.6	1.1	19.3	29.5	32.5	11.4	7.2

procedures to get things done. (Hierarchical)								
The IS department I work in, is a very production oriented place. People are concerned with getting the job done and are not very personally involved. (Rational)	3.1	1.2	10.8	18.1	31.9	25.3	13.9	
The glue that holds the IS department I work in together, is loyalty and tradition. Commitment to the IS department I work in runs high. (Group)	3.4	1.1	7.8	10.2	33.7	34.9	13.3	
The glue that holds the IS department I work in together, is commitment to innovation and development. There is an emphasis on being first with products and services. (Developmental)	3.4	1.2	7.2	14.5	27.7	30.7	19.9	
The glue that holds the IS department I work in together, is formal rules and policies. Following rules and maintaining a smooth-running institution are important. (Hierarchical)	2.9	1.2	14.5	23.5	31.9	18.7	11.4	
The glue that holds the IS department I work in together, is an emphasis on tasks and goal accomplishment. A production and achievement orientation is commonly shared. (Rational)	3.6	0.9	1.8	9.6	31.9	39.2	17.5	
The IS department I work in, emphasizes human resources. High morale in the IS department is important. (Group)	3.4	1.2	7.8	13.9	28.3	29.5	20.5	
The IS department I work in, emphasizes growth through acquiring new resources. Acquiring new products/services to meet new challenges is important. (Developmental)	3.2	1.2	7.8	21.1	25.3	31.9	13.9	
The IS department I work in, emphasises permanence and stability. Efficient, smooth operations are important. (Hierarchical)	3.6	1.1	4.8	9.0	25.9	38.0	22.3	

The IS department I work in, emphasizes competitive actions, outcomes and achievement. Accomplishing measurable goals is important. (Rational)	3.5	1.0	4.8	10.2	31.9	38.6	14.5
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Table 4-31 shows the descriptive statistics and Cronbach α when the items in Table 4-30 are grouped into the four groups, namely group, developmental, hierarchical and rational.

Table 4-31: Descriptive statistics: Organisational culture according to the Competing Values Framework

Culture	Mean	Std. Dev.	Cronbach α
Group	3.5	0.9	0.769
Developmental	3.4	0.9	0.740
Hierarchical	3.0	0.8	0.589
Rational	3.4	0.7	0.452

When determining the reliabilities on the cultures above it was found that some had a very low reliability. A PCA was performed thereafter on the 12 questions asked to determine the culture with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, $KMO = 0.886$, which is classified as *superb* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (66) = 769.240$, $p < 0.001$ tested whether the correlations between the items were sufficiently high. An initial analysis was run to obtain the eigenvalues for each component in the data, and two components had eigenvalues of more than one, according to the Kaiser Criterion. These two components explained a combined total of 56.62% of the total variance.

All the Cronbach α were above the minimum of 0.5 (Field, 2009:675), where component 1 had a high reliability, $\alpha = 0.887$, and the second component had a low reliability, $\alpha = 0.653$. This second component has been divided to use the two items separately.

Two components were retained, where component 1 represents the general culture, and component 2 represents the strong hierarchical culture. These reliabilities are presented at the foot of Table 4-32, together with the eigenvalues for each of these components after five iterations.

Table 4-32: Final component structure: Organisation culture

Organisation culture (F0)	General culture (F1)	Strong hierarchical culture (F2)
All items	The IS department I work in, emphasizes human resources. High morale in the IS department is important.	The IS department I work in, is a very formal and structured place. People pay attention to bureaucratic procedures to get things done.
	The IS department I work in, emphasizes competitive actions, outcomes and achievement. Accomplishing measurable goals is important.	The glue that holds the IS department I work in together, is formal rules and policies. Following rules and maintaining a smooth-running institution are important.
	The IS department I work in, is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.	The IS department I work in, is a very production oriented place. People are concerned with getting the job done and are not very personally involved.
	The glue that holds the IS department I work in together, is commitment to innovation and development. There is an emphasis on being first with products and services.	
	The IS department I work in, is a very personal place. It is like an extended family and people seem to share a lot of themselves.	
	The glue that holds the IS department I work in together, is loyalty and tradition. Commitment to the IS department I work in runs high.	
	The IS department I work in, emphasizes permanence and stability. Efficient, smooth operations are important.	
	The IS department I work in, emphasizes growth through acquiring new resources. Acquiring new products/services to meet new challenges is important.	

	The glue that holds the IS department I work in together, is an emphasis on tasks and goal accomplishment. A production and achievement orientation is commonly shared.	
Eigenvalues	4.86	2.20
Cronbach α	0.887	0.653
Mean	3.48	2.87

The mean of the responses have been calculated based on the components constructed, and the general culture (component one) had a higher mean response as the strong hierarchical culture (component two). These means are presented at the foot of Table 4-32. A Likert scale has been used where 1 = *Totally disagree*, and 5 = *Totally agree*.

Two questions were included to determine the uncertainty of the IS department or the organisation. Table 4-33 shows the descriptive statistics regarding the uncertainty.

Table 4-33: Descriptive statistics: Organisational uncertainty

N=166	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The IS department I work in, is under thread of being disbanded.	1.9	1.3	57.8	12.7	13.9	9.6	6.0
The future of the IS department in our organisation is uncertain.	1.9	1.2	56.6	14.5	15.1	8.4	5.4

These two items have been combined into one item, using the average of the responses provided. This one item then measured the uncertainty of the organisation or ISD. The average of this new item is calculated as 1.92 with a standard deviation of 1.20.

4.5.3 Time of SDM usage

Respondents had been asked to indicate the time they have already been using the current SDM in their organisation. Five options were presented from which respondents chose, as indicated in Table 4-29, together with the number and percentages of responses for each timeframe.

Table 4-34: Descriptive statistics: Time of SDM usage

	N	Percentage	Cumulative percentage
Less than one year	21	12.7%	12.7%
1 year or more – less than 2 years	24	14.5%	27.2%
2 years or more – less than 5 years	52	31.3%	58.5%
5 years or more – less than 10 years	32	19.3%	77.8%
10 or more years	31	22.3%	100%

Most of the organisations had used their SDM between two and five years, with just less than half of all the organisations having used the SDM for any time more than two years.

4.5.4 SDM tailoring

Tailoring of SDMs happens more often than is thought. One of the questions asked the respondents to indicate the extent to which they had tailored the list of SDMs (the same list as Table 4-5). This extent was measured on a Likert scale of five items, ranging from 1 = *Not at all* to 5 = *To a greater extent*. Table 4-35 provides the descriptive statistics.

Table 4-35: Descriptive statistics: Tailoring of SDMs

N=166	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
Scrum	3.39	1.52	23.5	3.0	14.5	28.9	30.1
SDLC	3.20	1.49	23.5	8.4	15.1	30.1	22.9
RAD	2.72	1.58	38.6	8.4	13.9	21.1	18.1
UML	2.50	1.46	40.4	11.4	16.3	21.7	10.2
XP	2.36	1.50	48.8	7.2	13.9	19.3	10.8
STRADIS	2.33	1.45	48.2	7.2	16.9	18.7	9.0
SSADM	2.06	1.40	59.0	3.0	18.7	11.4	7.8
WSDM	2.05	1.41	57.8	7.8	14.5	10.8	9.0
IE	1.95	1.35	62.0	6.0	12.0	14.5	5.4
OO-HDM	1.81	1.27	67.5	3.0	15.1	9.6	4.8
SSM	1.80	1.23	65.7	7.2	13.3	9.6	4.2

HDM	1.67	1.20	71.7	5.4	13.3	3.6	6.0
OMT	1.67	1.18	72.3	3.6	13.3	6.6	4.2
YSM	1.60	1.10	72.9	6.6	12.0	4.8	3.6
LBMS	1.58	1.07	73.5	5.4	14.5	3.0	3.6
JSD	1.58	1.09	74.1	4.8	12.7	5.4	3.0
Other	1.58	1.22	78.9	1.2	9.0	4.2	6.6
Merise	1.55	1.06	75.3	5.4	11.4	4.8	3.0

PCA was conducted on the list of 18 items with oblique rotation (oblimin). The KMO measure verified the sampling adequacy for this analysis, $KMO = 0.946$, which is classified as *superb* (Field, 2009:659). Bartlett's test of sphericity $\chi^2 (153) = 3087.087$, $p < 0.001$ tested whether the correlations between the items were sufficiently high. An initial analysis was run to obtain the eigenvalues for each component in the data, and three components had eigenvalues of more than one, according to the Kaiser Criterion. These three components explained a combined total of 72.49% of the total variance and were retained, where component 1 represented the other known (or unpopular) SDMs, component 2 the well-known (or popular) SDMs, and component 3 the agile SDMs used most.

All the Cronbach α were above the minimum of 0.5 (Field, 2009:675), except for component 3, where component 1 had a high reliability, component 2 a mediocre reliability, and component 3 had a very low reliability. These reliabilities are presented at the foot of Table 4-36, together with the eigenvalues for each of these components after eight iterations. Table 4-36 displays the final component structure, together with the sample size (N), the average (\bar{x}) and the standard deviation (s) for all the items.

Table 4-36: Final component structure: Tailoring of SDMs

SDM Tailoring (F0)	Other known SDMs (F1)	Well-known SDMs (F2)	Agile SDMs (F3)
All items	LBMS system development method	System Development Life Cycle (SDLC)	Scrum
	Merise	Structured Analysis, Design and Implementation of Information Systems (STRADIS)	Extreme Programming (XP)
	Jackson Systems Development (JSD)	Rapid application development (RAD)	Unified Modelling Language (UML)
	Yourdon Systems Method (YSM)		
	Object Modelling Technique by Rumbaugh (OMT)		
	Hypermedia design method (HDM)		
	Soft Systems Methodology (SSM)		
	Object oriented hypermedia design method (OO-HDM)		
	Other		
	Information Engineering (IE)		
	Structured Systems Analysis and Design Method (SSADM)		
	Web site design method (WSDM)		
Eigenvalues	9.807	4.763	3.339
Cronbach α	0.961	0.771	0.612
Mean	1.74	2.69	2.88

The mean of the responses was calculated based on the components constructed, indicating that the agile SDMs (component 3) were tailored more extensively than the other SDMs (component 1). The means are presented at the foot of Table 4-36.

4.5.5 Reasons for not adopting an SDM

For the respondents who indicated to no use of an SDM in their latest development project, a question was asked regarding why the organisation or ISD had not adopted an SDM. This question had not been linked to question 2.1 in the questionnaire, and therefore some respondents had not provided an answer to it. In the following table, an extra item has been included for completeness. The last row, labelled as “Missing” is the number of respondents who had not answered the question, but indicated to not using an SDM.

Table 4-37: Descriptive statistics: Reasons for not adopting an SDM

Item	N	Percentage	Mean	Std. Deviation
The IS department have never considered using SDMs.	10	31.3	1.90	0.77
The IS department have investigated some SDMs, but decided against the use thereof.	12	37.5		
The IS department have used some SDMs in the past, but not anymore.	7	21.9		
Missing	3	9.4		

4.5.6 Strictness and future use of SDM

Respondents who had used an SDM were asked to indicate to what extent they did so in the organisation (or ISD). As this question was not linked to the answer of question 2.1, all 134 respondents answered.

Table 4-38: Descriptive statistics: Strictness of SDM usage

N=134	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
Adopted on a project-by-project basis.	3.56	1.27	10.4	11.9	13.4	39.6	24.6
A general guideline for all projects.	3.79	1.10	6.0	6.7	17.2	42.5	27.6
A standard which is followed rigorously for all projects.	3.28	1.28	12.7	14.2	24.6	29.1	19.4

After the implementation of the SDM, regardless of the manner as explained above in Table 4-38, respondent had to indicate how they would feel towards the implementation of this SDM before the SDM could be used in the future. Table 4-39 presents the descriptive statistics for the responses. As this question was not linked to the answer of question 2.1, all 134 respondents answered it.

Table 4-39: Descriptive statistics: Future use of SDM

N=134	Mean	Std. Dev.	Percentage of frequency				
			1	2	3	4	5
The SDM used are appropriate for the development of the systems.	3.97	0.94	0.7	6.0	23.1	35.8	34.3
Some changes should be made before the SDM could be used again.	3.28	1.09	7.5	16.4	27.6	38.1	10.4
The SDM should undergo major changes before it could be used again.	2.49	1.23	30.6	16.4	31.3	16.4	5.2
The SDM is not suited for further development projects within the IS department.	2.27	1.35	44.0	13.4	22.4	11.9	8.2

The respondents felt very strongly that the SDM could not be used as it was, in the future, but also that it might be necessary that some changes should be made before its future use.

4.6 SUMMARY

The results of the data gathered using a survey (refer to Chapter 3) have been presented in this chapter, with the background of the respondents in the sampling frame. This chapter was divided into the three different sections according to the three levels investigated. The individuals comprised 87% males and 23 females. Almost half of the respondents aged between 26 and 35 years, and 61% were developers or programmers. Seventy-five percent of respondents had at least a university degree, and 59% more than five years of experience.

From the project level, it was found that the Scrum, SDLC and RAD SDMs were used more intensively in the 81% of projects using an SDM. Of all the projects, most were reported as being large, with a criticality of essential money. Some 46% were new development of systems, with only 34% having a future plan of only minor upgrades. The most systems were web systems (68%), developed in less than two years. Almost all (90%) of the systems were still in use, and interacted mostly with a relational database.

Most of the organisations involved were from the system development sector, the size being between 11 and 100 employees, existing between 10 to 15 years. Determining the culture, two were found, namely a general culture and the strong hierarchical culture. These organisations showed high levels of certainty, where the SDM was used between two and five years. It was further noticed that the Scrum, SDLC, and RAD SDMs were tailored the most, as they are also used the most intense.

CHAPTER 5

RESULTS ON THE ORGANISATIONAL LEVEL

5.1 INTRODUCTION

This chapter will be devoted to the discussion of the results on the organisational level. Firstly, the characteristics investigated will be outlined, followed by discussion of one of the research goals stated in Chapter 1 (section 1.3). These research goals are:

- i. identify the characteristics influencing the selection of an SDM on an organisational level.**
- ii. identify the characteristics influencing the selection of an SDM on a project level.
- iii. identify the characteristics influencing the selection of an SDM on an individual level.
- iv. develop the theoretical framework, based on the evaluation.

This chapter will focus on the first goal above (i) and will be discussed in the following sections.

5.2 CHARACTERISTICS INFLUENCING THE SELECTION OF AN SDM ON AN ORGANISATIONAL LEVEL

The first objective of this research is the identification of the characteristics influencing the selection of an SDM on an organisational level. Referring to the conceptual model constructed in Chapter 3 (section 3.7.5.1, Figure 3-2), four characteristics were included, namely organisational (1) sector, (2) size, (3) age and (4) culture and uncertainty. The following sections will address each of these characteristics.

In Chapter 2 (Table 2-6), only three previous models (one set of guidelines and two frameworks) were included as acknowledging the organisation, but only the framework of Davis (section 2.3.4.4) considered the organisation. The others mentioned that the organisation were involved, but when stating how the SDMs were chosen, those characteristics were part of the characteristics of the project (as stated in Table 3-1 in Chapter 3). The guidelines of Charvat (2003, section 2.3.1.3) included the size of the

team and project, as well as the criticality of the project. The framework of Cockburn (2000, section 2.3.4.1) included the size and the criticality of the project, similar to the guidelines of Charvat (2003), which are classified as characteristics of the project. The framework of Davis (Avispn & Fitzgerald, 2003b:595) included the uncertainty of the system in the organisation, and based on this the manner in which requirements should be gathered is derived.

5.2.1 Influence of the organisational sector

A predefined list of sectors has been used (see Annexure B for the questionnaire). Most of the organisations in this study are from the systems development, financial/banking and the consulting sectors, in which almost 90% of the respondents from these sectors indicated they had been using an SDM (section 4.5.1). The statistical techniques applied to this variable (section 4.5.1) were the crosstabs and correlation techniques. Some relationships identified with the correlations are reported, but as there was no order in the list of organisations this is merely academic.

On investigating whether each of these sectors had used an SDM (section 4.4) using the crosstabs technique, the majority of each of the sectors had, except for the government sector, of which only about a third of their organisations had. In contrast, only a third of the mining sector had *not* used an SDM. The manufacturing sector indicated that all organisations in this sector were using an SDM, with no organisations reporting to not doing so.

The sector was found to have a moderately positive relationship to the size ($r_s = .24$, $p < .01$) and a strong positive relationship to the age ($r_s = .42$, $p < .01$) of the organisation (section 4.5.2).

A small positive relationship has been found between the sector of the organisation, and the control the SDM provided as a project management (section 4.4.5) with $r_s = -.19$, $p < .05$. This could not be interpreted with great meaning as there was no order in the list of organisation sectors in the questionnaire.

In this section, it was found that the sector had an influence on the size and age of an organisation, as those in a certain sector tended to be operating longer and in different

ways. This could not be found to indicate what SDM these sectors were using, mainly because there was no order in the list of sectors measured. The other limitation has been that none of the sectors was sufficiently represented in the results, leading to low frequencies that could not be used.

5.2.2 Influence of the organisational size

Using the organisation size variable (section 4.5.2, Table 4-28), more than half of the organisations had more than 100 employees, with 27% also having more than 2,000. These large organisations mainly exist in the consulting, financial/banking, or healthcare sectors, and comprise more than 80% of all the large organisations (more than 2000 employees). More than 66% of organisations with more than 2,000 employees have an age of 30 or more years. Organisations with an employee count of between 500 and 2,000 are divided into ages of 15 to 20 years (28.0%) and more than 30 years (24.0%). When the number of employees is established as between 100 and 500, 60% of the organisations have ages of between 10 and 20 years, with 65% of the organisations of between 10 and 100 employees aged 5 to 15 years.

ANOVA was used to determine if any effects existed between various variables and the size of the organisation. These results are presented in Table 5-1:

Table 5-1: ANOVA results for the size against the intensity and perceived support provided by SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 3.99 2. 3.52 3. 3.71 4. 3.62 5. 4.33	4,129	.631
Intensity of unfamiliar SDMs	1. 2.19 2. 1.82 3. 1.44 4. 1.79 5. 2.20	4,129	.790
SDM control as project management	1. 3.52 2. 4.03 3. 3.96 4. 3.73 5. 3.92	4,127	1.756
Decomposition of system development	1. 3.69 2. 3.99	4,127	.818

	3. 4.04		
	4. 3.84		
	5. 4.09		

For the size towards the intensity of SDMs used (section 4.4.1), no statistically significant effects were found. This is also true for the size towards the SDM control as a project management and the decomposition of the system developed (section 4.4.4.1).

From a further analysis of the size and degree to which SDMs were tailored (section 4.5.4, see Table 5-2), no significant effect could be found when using all three the components of the degree to which SDMs were tailored in this study. This corresponds with Huisman (2000:160), with no relationship found between the size of an organisation and the use of SDMs, both studies having been conducted in South Africa.

Table 5-2: ANOVA results for the size against tailoring of SDMs

Variable	Mean	df	F
Tailoring of other known SDMs	1. 1.82 2. 1.64 3. 1.52 4. 1.80 5. 2.09	4,161	1.333
Tailoring of well-known SDMs	1. 2.55 2. 2.67 3. 2.71 4. 2.69 5. 2.82	4,161	.183
Tailoring of Agile SDMs	1. 2.94 2. 2.83 3. 2.47 4. 2.90 5. 3.35	4,161	.193

The following table will provide all the variables used in this chapter for measuring the use (Table 5-3) and non-use (Table 5-4) of the SDM, as well as the correlations for three of the characteristics of the organisation (sections 5.2.1 to 5.2.3)

Table 5-3: Correlations of organisation characteristics and the use of an SDM

Variable	Size	Age
Intensity of more familiar SDMs	.12	-.11
Intensity of unfamiliar SDMs	.08	.00
Intensity of in-house SDMs	.02	.08
Intensity of Scrum	.05	-.08
Control provided as Project Management	.03	.11
Decomposition of system development	.07	.12
Time of use	.27**	.37**
Tailoring of other known SDMs	.07	.00
Tailoring of well-known SDMs	.06	-.01
Tailoring of agile SDMs	.08	-.05
Strictness of use: adapted on project-to-project basis	-.04	-.12
Strictness of use: used as general guideline	-.18	-.12
Strictness of use: a standard with is used rigorously	.05	-.02

* $p < .05$, ** $p < .01$, *** $p < .001$

The table above indicates that a weak (almost moderate) positive relationship exists between size and the time of use of the SDM ($r_s = .27$), but this relationship is statistically significant with $p < .01$. This indicates that the longer the organisation exists the longer they have been using an SDM.

The relationship of the size of the organisation was also found to have a strong positive relationship to the age with $r_s = .56$, $p < .01$. A weak positive relationship has been found between the size of the organisation, and the size of projects, $r_s = .16$, $p < .05$. About 51% of all projects with a medium or large size were reported in 50% of organisations, those with 100 or fewer employees. This is a relative statistic, as the size of a project will be classified differently for those organisations with fewer than 100 employees and more than 2,000.

A rather weak negative relationship has been found between the size of the organisation and the strictness of use of an SDM as a guideline, $r_s = -.18$, $p < .05$, meaning that as the organisations grow they tend to use the SDM less as a general guideline. This could

mean that they adapt and tailor the SDM gradually over time, making it ideal for use in their specific organisation.

Table 5-4: Correlations of organisation characteristics and the non-use of an SDM

Variable	Size	Age
Non-adoption of SDMs	.25	.17
Reasons for non-use:	-	-
Environment not supporting	-.08	-.10
Lack of experience	.04	-.04
Uncertainty	.12	.22
Long-term commitment	-.07	-.03

Table 5-4 indicates the correlations for the size of the organisation and the variables used to measure the non-use of an SDM. It is evident from the table that no significant relationships could be found, indicating that the size of the organisation does not contribute to the non-use of SDMs.

As the size of the organisation did not have any significant relationship with the other characteristics. It is concluded that size is not regarded as one of the characteristics that influence the selection of which SDM to use. The size of the organisation does contribute to the time of use of the SDM, as well as the less strict application of the SDM as a general guideline.

5.2.3 Influence of the organisational age

The age of the organisation (section 4.5.2, Table 4-29) has been measured using seven time intervals, with increments of five years. Most of the organisations existed between five and 15 years, or more than 30 years.

The correlations for the age of the organisation are reported in Table 5-3 for the use of an SDM. It is noted that the time of use is moderately related to the age of the organisation ($r_s = .37, p < .01$), which indicates that the sector, size and age of an organisation are

related to the time the SDM is used. As one of these characteristics increases so does the time that the SDM will be used.

A strong positive relationship was found between age and the size, meaning that the longer the organisation existed the more the organisation grew, $r_s = .56$, $p < .01$. In the previous section, it was concluded that the size did not have a relationship with the selection of SDMs.

A moderate relationship has been found between the age and the strong hierarchical culture of the organisation, $r_s = .24$, $p < .01$, which means that as the age of the organisation increases the culture tends to become more hierarchical.

A weak relationship has been found between the age of the organisation and the success of the system (section 4.4.4.10), $r_s = .17$, $p < .05$, which indicates that organisations need to grow significantly in age before a significant difference in the success of the system will be seen. This can be explained by the growth of developers in line with that of the organisation, when the organisation allows it, increasing familiarity with the system and its role within the organisation, and the use of the SDM to develop this system. This can further be explained by the relationship with the high experience of developers in the use of the SDM (section 4.4.4.5, Table 4-19) with $r_s = .20$, $p < .01$. This also means that the older the organisation becomes, or the longer it uses the SDM, the more experience the developers gain in using and applying it.

In performing an ANOVA analysis on the age of the organisation and the intensity of use of SDMs, the support provided by the SDM as control technology, and the tailoring of SDMs, no significant effect was found (Table 5-5 below). The categories of 20-25 years of age have been insufficiently represented and are thus excluded from analysis.

Table 5-5: ANOVA results for the age against usage of SDM

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 4.36 2. 3.86 3. 3.44 4. 3.40 7. 3.99	4,116	.613
Intensity of unfamiliar SDMs	1. 2.15 2. 1.90 3. 1.44 4. 1.58 7. 2.03	4,116	.749
SDM control as project management	1. 3.62 2. 3.92 3. 3.91 4. 3.63 7. 4.06	4,114	1.277
Decomposition of system development	1. 3.92 2. 4.03 3. 3.81 4. 3.72 7. 4.18	4,114	1.294
Tailoring of other known SDMs	1. 1.40 2. 1.91 3. 1.75 4. 1.54 7. 1.80	6,159	.622
Tailoring of well-known SDMs	1. 2.50 2. 2.73 3. 2.83 4. 2.49 7. 2.75	6,159	.645
Tailoring of Agile SDMs	1. 2.87 2. 3.00 3. 2.81 4. 2.70 7. 2.74	6,159	1.306

It is concluded that the age of an organisation is not one of the influences on the selection of an SDM, but it does influence the success of the system and the experience of the developers.

5.2.4 Influence of the organisational culture and uncertainty

The Competing Values Framework (CVF) has been used to determine the culture of the organisations. Initially, Huisman (2000:135) found four types of cultures within organisations, then six (Huisman, 2013:9). These included a strong comprehensive culture, a moderate hierarchical and rationally oriented culture, a strong group and developmentally oriented culture, a weak comprehensive culture, a very strong comprehensive culture, and a moderate non-hierarchical culture. The cultures found in organisations in this study can be grouped into two (section 4.5.2), as *general*, and *strong* hierarchically. This is in contrast with both the above cases reported by Huisman (2000:135; 2013:9).

Correlations have been used to determine relationships between the general culture, the strong hierarchical culture and the uncertainty within the organisation against the variables to measure the use of the SDM.

Table 5-6: Correlations of organisation culture and uncertainty and the use of an SDM

Variable	General culture	Strong hierarchical culture	Uncertainty
Intensity of more familiar SDMs	.12	.22*	.19*
Intensity of unfamiliar SDMs	.10	.33**	.26**
Intensity of in-house SDMs	.07	.05	.01
Intensity of Scrum	.27**	-.12	-.01
Control provided as project management	.22*	.25**	-.04
Decomposition of system development	.36**	.26**	.02
Time of use	.09	.07	-.04
Tailoring of other known SDMs	.19*	.18*	.31**
Tailoring of well-known SDMs	.22**	.24**	.25**
Tailoring of Agile SDMs	.10	-.03	.15
Strictness of use: adapted on project-to-project basis	.40**	.08	.02
Strictness of use: used as general guideline	.32**	.10	-.05
Strictness of use: a standard with is used rigorously	.36**	.31**	.05

* $p < .05$, ** $p < .01$, *** $p < .001$

The general culture indicated no relationship with the use of familiar, unfamiliar or in-house developed SDMs. It had a moderate relationship with the use of the Scrum SDM, $r_s = .27$, $p < .01$. A moderate relationship was found between the unfamiliar SDMs and the strong hierarchical culture, $r_s = .33$, $p < .01$, indicating that a certain SDM is enforced on employees from top management in an organisation with a strong hierarchical culture. Another explanation could be that the SDM being used by the organisation was new at the time of investigation for adoption, further directed by the buzzword (section 4.4.2, Table 4-8) of the time. The strong hierarchical culture indicated a negative relationship with the intensity the Scrum SDM is used, indicating that a hierarchical culture tends to use more formalised SDMs than that of an agile nature.

Looking into the support the SDM provided as a control technology (section 4.4.4.1), the general culture had a weak relationship with the SDM control as project management ($r_s = .22$, $p < .05$), and a moderate positive relationship with the decomposition of the system ($r_s = .36$, $p < .01$). The strong hierarchical culture also had a moderate relationship with the SDM control as project management ($r_s = .25$, $p < .01$) as well as the decomposition of the system ($r_s = .26$, $p < .01$), which are all statistically significant. This indicates that the culture does not predict how the SDM will provide control as project management, or the decomposition of the system.

Looking at the success of the system, a strong positive relationship has been found between the general culture and the success of the system, $r_s = .43$, $p < .01$. No relationship has been found with the hierarchical culture, indicating that as the culture is more of a general type the success of the systems increases. The culture, therefore, has an influence on the success of the system.

The following table lists the variables used to measure the non-use of SDMs in organisations, and shows the correlations for the two types of culture and the uncertainty in the organisation.

Table 5-7: Correlations of organisation culture and uncertainty and the non-use of an SDM

Variable	General culture	Strong hierarchical culture	Uncertainty
Non-adoption of SDMs	-.07	.19	.11
Reasons for non-use:	-	-	-
• Environment not supporting	.46**	.29	-.24
• Lack of experience	.09	.12	-.06
• Uncertainty	-.12	.14	-.05
• Long-term commitment	-.49**	.26	-.02

* $p < .05$, ** $p < .01$, *** $p < .001$

Investigating the projects that used no SDM during the last project, the relationships are depicted in Table 5-7. No relationships could be found regarding the reasons for not adopting any SDM within the organisation (or IS department). It has been found, however, that the environment and the long-term commitment have strong relationships with the general culture ($r_s = .46$, $p < .01$ and $r_s = .49$, $p < .01$ respectively). This means that the environment in this case, becomes more unsupportive with a general culture, and a long-term commitment is needed. Both these relationships are also statistically significant with $p < .01$. It is however noticeable that the strong hierarchical culture did not indicate any relationships with not adopting an SDM, which could mean that the top management had chosen an SDM and enforced it on the developers.

Uncertainty has been part of the question determining the culture of an organisation (section 4.5.2, Table 4-33). Respondents have indicated that they have very low levels of uncertainty in the organisations they work for, meaning that they do still see themselves in the organisation in the future. Table 5-6 indicates that positive relationships exist towards the intense use of more familiar SDMs ($r_s = .19$, $p < .05$), as well as with the intense use of unfamiliar SDMs ($r_s = .26$, $p < .01$). The relationship is stronger for the intense use of unfamiliar SDMs, and is more statistically significant than the intense use of familiar SDMs. The correlations also indicate that the well-known SDMs ($r_s = .31$, $p < .01$) and other SDMs ($r_s = .25$, $p < .01$) will be tailored more when the levels of uncertainty rises.

The framework of Davis (section 2.3.4.4) used uncertainty of the system (or the uncertainty of the system within the organisation) to determine how to gather requirements for the system. Section 4.4.4.5, Table 4-19, indicates the three separate variables used to measure the requirements. From the correlation analysis, the uncertainty was found to have relationships with only two. The relationship towards the variable labelled *The requirements from users were understandable to the developers*, was negative with $r_s = -.15$, $p < .05$. The relationship with the third variable labelled *Conflicting requirements were present during the project* indicated a positive relationship with the levels of uncertainty ($r_s = .20$, $p < .05$). These do not contradict the framework of Davis, and could therefore be included in the framework constructed in Chapter 9.

Performing regression analysis between the cultures, uncertainty and the intensity of SDMs usage, as well as the support provided by the SDM as a control technology have been found to be significant. Table 5-8 reports the regression analysis of the dependent variables of familiar SDMs and unfamiliar SDMs.

Table 5-8: Regression results for organisation culture and uncertainty to predict the use of familiar and unfamiliar SDMs (N=134)

Dependent variable	Familiar SDMs			Unfamiliar SDMs		
	B	SE B	β	B	SE B	β
General culture	.597	.232	.216*	.474	.183	.214*
Strong hierarchical culture	.431	.200	.188*	.417	.158	.226**
Uncertainty	.339	.146	.194*	.287	.115	.205*
R^2	.161			.190		
f^2	.192			.235		
F	8.320***			10.143***		

* $p < .05$, ** $p < .01$, *** $p < .001$

The regression analysis reported above explains only a small part of the variance (less than 20%), indicating that not only these variables can be used to predict the use or intensity of SDMs. All the models also indicated to be of statistical significance, indicating that using this model results in a better estimate than using the mean values for these variables. Both effect sizes (f^2) are classified as a medium effect, which is practically

significant. The model reported in Table 5-8 indicates that both cultures, together with uncertainty, contribute significantly to the use of familiar and unfamiliar SDMs.

Table 5-9: Regression results for organisation culture and uncertainty to predict the SDM control as project management and decomposition of the system (N=132)

Dependent variable	SDM control as Project Management			Decomposition of the system		
	B	SE B	β	B	SE B	β
General culture	.111	.083	.116	.278	.088	.273**
Strong hierarchical culture	.215	.072	.268**	.149	.077	.174
Uncertainty	-.144	.052	-.237**	-.014	.056	-.022
R^2	.125			.130		
f^2	.14			0.15		
F	6.113**			6.393***		

* $p < .05$, ** $p < .01$, *** $p < .001$

The two regressions reported above are of statistical significance. It should be noted that both models only explain about 13% of the variance. This indicates that not only the organisational factors are involved in the choice. Other factors, such as the project and individual will contribute to the explanation of a greater percentage of the variance. The effect size for the first model predicting the SDM control as project management is small, but the effect size for the second model, predicting the decomposition of the system, is classified as a medium effect only. The model presented in Table 5-9 (above) indicates that the general culture contribute significantly to the decomposition of the system, while the strong hierarchical culture contribute significantly to the SDM control as project management.

Table 5-10: Regression results for organisation culture and uncertainty to predict the tailoring of SDMs (N=132)

Dependent variable	Tailoring well-known SDMs			Tailoring other SDMs			Tailoring Agile SDMs		
	B	SE B	β	B	SE B	β	B	SE B	β
General culture	.317	.108	.221**	.277	.093	.215**	.251	.122	.163*
Strong hierarchical culture	.192	.098	.153	.140	.085	.124	-.146	.112	-.108
Uncertainty	.210	.072	.220**	.291	.062	.340***	.184	.082	.180*
R^2	.151			.208			0.049		
f^2	0.18			0.26			.05		
F	9.635***			14.176***			2.801*		

* $p < .05$, ** $p < .01$, *** $p < .001$

The three models presented in Table 5-10 indicate that all the models are of statistical significance, where the general culture and the uncertainty contribute to the tailoring of any SDM, and the strong hierarchical culture indicate to have no statistical significance. The effect size indicated that the models for tailoring well-known and other SDMs are of a medium practical effect ($f^2 = 0.18$ and $f^2 = 0.26$ respectively), while the tailoring of agile SDMs reports a very low effect size ($f^2 = 0.05$). It is noted that the uncertainty and the general culture have influence on the tailoring of SDMs.

The culture also had relationships with the manner in which the organisation uses an SDM. The general culture had a strong relationship with the adoption of the SDM on a project-to-project level ($r_s = .40$, $p < .01$), while a moderate relationship exists when the SDM is used as a general guideline ($r_s = .32$, $p < .01$) and followed rigorously ($r_s = .36$, $p < .01$). The strong hierarchical culture only showed a moderate relationship with the rigorous usage of the SDM with $r_s = .31$, $p < .01$. This is because, as the culture becomes more hierarchical, top management seeks to enforce the use of the SDM as strictly as possible, not allowing too much change.

In this section, the culture and uncertainty of an organisation has an influence on the use of SDMs, but only the general culture and the uncertainty influence whether SDMs will be tailored. It is also evident that the hierarchical culture indicates the strict use of an SDM as a standard, where the general culture indicates that an SDM can be used on any level

of strictness. The general culture also prefers to use the Scrum SDM more intensely, while the hierarchical culture uses unfamiliar SDMs more intensely. The general culture influences the success of the system in a positive manner.

With the non-use of SDMs, when the culture becomes more general, there exists a relationship indicating that there is an environment which may not support SDMs, or is rejected due to a long-term commitment. The hierarchical culture does not indicate why SDMs may not be used.

The uncertainty only indicated that SDMs will be used but will be tailored more when the levels of uncertainty rise in the organisation.

5.3 SUMMARY

This chapter has been devoted to discussion of the results on the variables used to measure characteristics of the organisation. It indicated that the size, age, culture and uncertainty of the organisation are contributing to the selection of SDMs. The next chapter will discuss the characteristics on a project level that may have an influence on the selection of an SDM.

CHAPTER 6

RESULTS ON THE PROJECT LEVEL

6.1 INTRODUCTION

This chapter will be devoted to discussion of the results on the project level. Firstly, the characteristics investigated will be noted, followed by the discussion of one of the research goals stated in Chapter 1 (section 1.3). These research goals are to:

- i identify the characteristics influencing the selection of an SDM on an organisational level.
- ii identify the characteristics influencing the selection of an SDM on a project level.**
- iii identify the characteristics influencing the selection of an SDM on an individual level.
- iv develop the theoretical framework, based on the evaluation.

This chapter will focus on the second goal stated above (ii) and will be discussed in the following sections.

6.2 CHARACTERISTICS INFLUENCING THE SELECTION OF AN SDM ON A PROJECT LEVEL

The second objective of this research is the identification of the characteristics influencing the selection of an SDM on an organisational level. Referring to the conceptual model constructed in Chapter 3 (3.7.5.1, Figure 3-2), 20 characteristics were included, that is the project's (1) size, (2) criticality, (3) nature, (4) system future, (5) development time, (6) database interaction, (7) platform, (8) external interaction, (9) complexity, (10) cost limitations, (11) time limitations, (12) change management, (13) development team, (14) tools and techniques, (15) requirements, (16) goals and visions, (17) legacy support, (18) maintenance plan, (19) duration, and (20) team size. The following sections will address each of these characteristics.

6.2.1 Influence of the project size

The variable of project size (4.4.4.2, Table 4-13) indicated that 69.8% were classified as being either medium or large, and 16.3% of projects as very large. This variable is included in Table 6-1 (below), displaying the correlations reported towards the variable used to measure the use of an SDM.

A weak relationship has been found between the size of the project and the control of the SDM as project management, $r_s = .18$, $p < .05$. Another weak positive relationship indicates that the size of the project is related to the intensity of the usage of more familiar SDMs ($r_s = .18$, $p < .05$), with a moderate relationship to the tailoring of these well-known SDMs ($r_s = .24$, $p < .01$). This indicates that, as the project grows, they are more likely to use SDMs that are more familiar, and to tailor those ones to work for the project. The size also related positively to the intense use of unfamiliar SDMs ($r_s = .19$, $p < .05$) and the intense use of Scrum ($r_s = .21$, $p < .05$). The strongest relationship exists between the size and the intensity of the use of the Scrum SDM. The unfamiliar SDMs are also tailored when they are used ($r_s = .16$, $p < .05$). The size of the project was also found to be in relation to the use of the SDM as a general guideline ($r_s = .19$, $p < .05$), but more statistically significant is the relationship to the use of the SDM as a standard with $r_s = .25$, $p < .01$.

Table 6-2 presents the results of the correlation to the variables to measure the non-use of the SDM. No significant relationship could be found to indicate that the size of the project had any influence on not using an SDM.

It is concluded that the size of the project has an influence on the use of an SDM, as well as the tailoring thereof. The size also indicates how the SDM should be adopted, in this case, as a standard (or a general guideline).

Table 6-1: Correlations of some project characteristics and the use of an SDM

Variable	Size	Criticality	Nature	System future	Development time	External interaction	Platform
Intensity of more familiar SDMs	.18*	-.08	-.06	-.04	.05	-.03	.14
Intensity of unfamiliar SDMs	.19*	-.10	.00	.05	.03	.08	.18*
Intensity of in-house SDMs	.08	.04	.10	.06	.07	.04	.13
Intensity of Scrum	.21*	-.02	-.16	.01	-.10	.09	.14
Control provided as project management	.18*	.00	.09	-.06	.03	-.01	-.15
Decomposition of system development	.09	.03	-.10	-.17*	-.06	-.19*	-.03
Time of use	.15	.27**	.05	.16*	.22**	.23**	-.14
Tailoring of other known SDMs	.16*	.00	-.07	-.03	.08	-.06	.13
Tailoring of well-known SDMs	.24**	.02	-.09	-.06	.10	-.07	.04
Tailoring of Agile SDMs	.11	.13	-.07	.07	.07	.08	.15
Strictness of use: adapted on project-to-project basis	.16	-.07	-.09	-.09	-.02	-.10	.03
Strictness of use: used as general guideline	.19*	-.02	.09	-.16	-.09	-.18*	-.04
Strictness of use: a standard which is used rigorously	.25**	.02	.16	-.06	.04	-.14	-.11

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 6-2: Correlations of some project characteristics and the non-use of an SDM

Variable	Size	Criticality	Nature	System future	Development time	External interaction	Platform
Non-adoption of SDMs	-.09	.06	.13	.12	-.14	-.05	.27
Reasons for non-use:	-	-	-	-	-	-	-
Environment not supporting	.04	.13	-.26	-.17	-.04	-.17	-.10
Lack of experience	.15	.33	-.10	.10	.08	-.25	-.06
Uncertainty	-.14	.35*	.06	.23	-.24	.26	-.12
Long term commitment	-.26	.24	.08	-.06	-.21	-.16	-.11

* $p < .05$, ** $p < .01$, *** $p < .001$

6.2.2 Influence of the project criticality

The variable measuring the criticality had four predefined answers (section 4.4.4.2, Table 4-14), listed as loss of comfort, loss of discretionary money, loss of essential money, and loss of life. More than half of the projects involved in this study indicated that the criticality of the system developed within this project would result in a loss of essential money.

Table 6-1 presents the results of the correlation of this variable towards the other variables used to measure the use of SDMs. One rather weak, but statistically significant, relationship was present, indicating that the criticality of the project had a positive relationship with the time of use of the SDM, with $r_s = .27$, $p < .01$. This could mean that the more critical the project becomes the more the SDM will be applied and used for a longer time in the organisation, and with which the organisation is more familiar.

The criticality of the project had a positive relationship with the size of the project, implying that as the project becomes more critical its size also increases ($r_s = .21$, $p < .01$). There was also a moderately positive relationship between the criticality and whether the project recognised the criticality of the system, with $r_s = .32$, $p < .01$ – indicating that the criticality of both the system and the project were related.

Regarding the variables used to measure the non-use of an SDM (Table 6-2), a moderate relationship was found between the criticality of the project and uncertainty as reason not to use an SDM ($r_s = .35$, $p < .05$). This uncertainty will mean that no SDM is used when the project becomes more critical.

From the results above, it cannot be concluded that the criticality had an influence on the selection and use of an SDM. This characteristic had an influence on the size of the project, the time the SDM was used, and the criticality of the system.

6.2.3 Influence of the project nature

The nature of a project could indicate a new development of a system, upgrading the current system, or a complete revision of the current system (Table 4-15 in section 4.4.4.2). The frequencies were distributed over all three options, but almost half of all the

projects reported a new system being developed. Table 6-1 indicated no relationship for this variable towards the other variables used to measure the use of an SDM.

A relationship was found between the nature of the project and the timely provision of data in the implementation phase. This indicated that the projects taking on a complete revision of the system required more information on when this new system had been implemented, opposed to the lower amount of data needed when the system was a new development ($r_s = .59, p < .01$). It was also found that the communication of the team with the use of technology lessened when the project was using a previous system, such as updating the system, or revising it, with $r_s = -.23, p < .01$. This is also related to the development time, as the new developments had shorter development times than did the projects with a complete redevelopment of the old system ($r_s = .23, p < .01$).

Table 6-2 also indicates that relationships have no statistical significance for the variables used to measure the non-use of SDMs. It can therefore be concluded that the nature of the project does not indicate the use of non-use of an SDM. However, it does indicate whether timely provision of information is needed, and the use of technology for communication purposes. The development time also increased with the nature of the project.

6.2.4 Influence of the project planned future

After the development of a system, certain actions are planned, including to perform only maintenance, minor/major upgrades, or to develop new versions of the current system. This has formed the predefined answers for this variable (Table 4-16 in section 4.4.4.2). More than 60% of all projects involved minor or major upgrades to the system.

The correlation results are presented in Table 6-1 for using an SDM. The planned future of the system was negatively influenced by the decomposition of the system with $r_s = -.17, p < .05$. This can be explained as the system is more decomposed while being developed; the planned future will tend to be more of a maintenance type for the system, rather than developing new versions or having major upgrades. Another explanation could be that the project is of an agile manner, focusing on increments for the future. The time the SDM has been in use also reflected a weak positive relationship to the planned

future of the system ($r_s = .16, p < .05$). No further relationships could be found with the variables measuring the non-use of an SDM (Table 6-2).

It can therefore be concluded that the planned future of the system does not contribute to the selection or use of an SDM. It does however influence the decomposition of the system and the time the SDM will be used.

6.2.5 Influence of the project development time

Although a project has its own duration (section 6.2.19), a certain time is allocated to the development of the system. This variable was used to determine the time it actually took the team (section 6.2.20) to develop the system. Just over 80% of all projects had a developmental time of less than two years, with 59% completed within one year.

Regarding the relationships this variable has with those measuring the use of an SDM (Table 6-1); only one was of statistical significance. This weak positive relationship existed between the development time and the time the SDM had been used ($r_s = .22, p < .01$). Various additional relationships have been found in relation to the development time of a project:

- The development time decreased as the process was more of a highly efficient nature (section 6.2.5), $r_s = -.26, p < .01$.
- As the size of the project increases (section 6.2.1), the time for development also increases, $r_s = .43, p < .01$ (a rather high moderate relationship).
- The interaction of external systems (section 6.2.6) also increased the development time, $r_s = .22, p < .01$. This is true as the current system needs to work with the other, already working systems, complying with their input and output.
- The development time increases as the project was regarded with a complex nature, $r_s = .31, p < .01$.
- Negative relationships have been found with the completion of the project within the budget ($r_s = -.26, p < .01$), and within the schedule ($r_s = -.21, p < .01$) as the

development time increases. This could be true, as the complexity of the system was not taken into account during the setting of the schedule and/or budget.

No statistically significant relationship was evident in Table 6-2 measuring the relationships between this variable and those variables measuring the non-use of an SDM.

It can be concluded that the development time does not contribute to the selection and use of an SDM, but it does contribute to other characteristics, such as the time of use, the complexity, the efficient process.

6.2.6 Influence of the projects' external interaction

Systems may interact with other systems that perform some functions needed, but it is not necessary to reproduce those within the system. This variable measured how many systems were needed to interact with this system (section 4.4.4.3).

The explanation above can be verified with the relationship between the interaction of external systems and the decomposition of the system ($r_s = .19, p < .05$). These results are presented in Table 6-1. Although the relationship is rather weak it is still statistically significant. A negative relationship using the SDM as a guideline ($r_s = -.18, p < .05$) indicates that when external systems need to be interacting with the developed system the SDM should preferably not be used as a guideline. No statistically significant relationships were found with the strictness of the SDM to be used in these cases.

A few other positive (but rather weak) relationships have been found between the interaction of external system with the size of the project ($r_s = .27, p < .01$); the criticality of the project ($r_s = .26, p < .01$); the time needed for development ($r_s = .22, p < .01$); and a moderate relationship between the external interactions and the complexity of the system ($r_s = .31, p < .01$).

The variables used to measure the non-use of an SDM (Table 6-2) produced no significant relationships.

It is concluded from this section that the external interaction of the system does not indicate the use or non-use of an SDM, but that it does influence the decomposition and complexity of the system and the size and criticality of the project.

6.2.7 Influence of the projects' platform

The platform for the system is increasingly web-based, with mobile telephones and desktop computers decreasing (section 4.4.4.4). This is evident in that more than two thirds of the projects developed a web-based system.

The projects which developed systems on a mobile platform did not have a well-planned implementation or adoption plan as opposed to those projects that have developed a desktop system ($r_s = -.55, p < .05$). This could be explained as these mobile applications are only now receiving more popularity whilst systems are moving to web-based applications. Table 6-1 did not indicate any relationship between the platform and the variables used to measure the use of an SDM. Only one statistically significant relationship was found whereby the platform was related to the intense use of unfamiliar SDMs ($r_s = .18, p < .05$). This could be explained by most of the SDMs presented in the questionnaire having been developed for desktop systems. They may therefore be unfamiliar to the developers as they tend to be more recently developed SDMs.

No significant relationships have been found in Table 6-2 for the variables measuring non-use of an SDM. It can be concluded that the platform do indicate a selection and use of an SDM. It does also influence the installation/adoption plan.

6.2.8 Influence of the projects' use of databases

Types of databases have been presented to the participants to indicate to what extent they have been used in the latest projects. The relational database had the highest score indicated as it had been used the most.

Correlations have been used to determine relationships between the network database (NDB), hierarchical database (HDB), rational database (RDB), object-oriented database (OO-DB), object-relational database (OR-DB) and a data warehouse (DW) against the variables to measure the use of the SDM.

Table 6-3: Correlations of type of databases and the use of an SDM

Variable	NDB	HDB	RDB	OO-DB	OR-DB	DW
Intensity of more familiar SDMs	.25**	.39**	.01	.39**	.39**	.11
Intensity of unfamiliar SDMs	.19*	.48**	.04	.29**	.33**	.14
Intensity of in-house SDMs	-.06	.11	.00	.05	.06	-.02
Intensity of Scrum	.12	.05	.02	.11	.11	.07
Control provided as project management	-.01	.16	.06	.13	.19*	.17
Decomposition of system development	.06	.15	.07	.22*	.26**	.01
Time of use	-.09	-.04	.04	.02	.00	.06
Tailoring of other known SDMs	.31**	.43**	.00	.29**	.41**	.22**
Tailoring of well-known SDMs	.20*	.35**	.02	.30*	.49**	.31**
Tailoring of agile SDMs	.10	.14	.02	.10	.21**	.15
Strictness of use: adapted on project-to-project basis	.16	-.03	.05	.17	.06	.13
Strictness of use: used as general guideline	-.08	-.02	.13	-.01	-.01	-.14
Strictness of use: a standard which is used rigorously	.07	.27**	.11	.13	.14	.03

* $p < .05$, ** $p < .01$, *** $p < .001$

These results provide relationships which are of value. Four of the six types of databases indicate rather strong relationships with the intense use of more familiar as well as unfamiliar SDMs. No relationships were found to be significant towards the in-house and Scrum SDMs. It could be further noted that the tailoring of well-known and other (non-agile) SDMs found strong positive relationships with five of the six types of databases. Some of these are rather strong, especially those of the object-related databases. It is of interest that, although the relational databases were used the most there were no relationships found towards this type of database. The other significant relationship was that between the hierarchical database and the use of the SDM as a standard ($r_s = -.27$, $p < .01$).

The following table lists the variables used to measure the non-use of SDMs in organisations, and provide the correlations for the types of databases.

Table 6-4: Correlations of types of databases and the non-use of an SDM

Variable	NDB	HDB	RDB	OO-DB	OR-DB	DW
Non-adoption of SDMs	-.31	.05	-.04	-.22	-.09	.06
Reasons for non-use:	-	-	-			
Environment not supporting	-.07	.27	-.22	.26	.26	-.05
Lack of experience	.06	.27	-.15	.19	.11	-.25
Uncertainty	-.12	.03	-.16	.02	.09	.29
Long term commitment	-.18	-.05	.10	-.13	.04	-.03

The table above indicates that no relationships were found between the types of databases and the non-use of SDMs. It is concluded that the type of DB used will influence the intensity and tailoring of SDMs. It is of interest that the most popular DB used (the relational DB) does not indicate any relationship with any of the variables. This may be true as the RDB may be familiar to developers today, and that SDMs are used when a somewhat unfamiliar type of DB is used in the project.

6.2.9 Influence of the project complexity

Three questions were included in the questionnaire to address the project complexity (section 4.4.4.5, Table 4-19). These three questions will each be individually addressed, which are:

- i *The project recognised the level of complexity of the system (Complexity 1)*
- ii *The system developed was of a complex nature (Complexity 2)*
- iii *The problem complexity was very high (Complexity 3)*

Correlations have been used to determine relationships between these three questions regarding the project complexity against the variables to measure the use of the SDM.

Table 6-5: Correlations of project complexity and the use of an SDM

Variable	Complexity 1	Complexity 2	Complexity 3
Intensity of more familiar SDMs	-.02	-.04	-.03
Intensity of unfamiliar SDMs	.01	-.02	-.04
Intensity of in-house SDMs	-.13	-.08	.00
Intensity of Scrum	.12	-.01	.01
Control provided as project management	.22*	.12	.09
Decomposition of system development	.18*	-.04	.06
Time of use	.31**	.21**	.16*
Tailoring of other known SDMs	.01	-.02	-.03
Tailoring of well-known SDMs	.08	.10	.20*
Tailoring of agile SDMs	.16*	.00	.06
Strictness of use: adapted on project-to-project basis	.10	.06	.07
Strictness of use: used as general guideline	.07	-.11	.06
Strictness of use: a standard which is used rigorously	.11	.02	.08

* $p < .05$, ** $p < .01$, *** $p < .001$

i *The project recognised the level of complexity of the system (Complexity 1)*

A moderately positive relationship was found (as presented in Table 6-5) between the time of use of the SDM and the first question regarding the complexity of the project with $r_s = .31$, $p < .01$. Other small relationships exist between the SDM provided control as project management ($r_s = .22$, $p < .05$), the decomposition of the system ($r_s = .18$, $p < .05$), and the tailoring of agile SDMs, with $r_s = .16$, $p < .05$. This indicates that the SDM should provide more support as the complexity of the project increases.

The complexity of the system had a statistically significant relationship to the size of the project, with $r_s = .22$, $p < .01$, the criticality of the project ($r_s = .32$, $p < .01$) as well as the external interactions ($r_s = .29$, $p < .01$). The complexity also had positive relationships with the use of appropriate techniques ($r_s = .31$, $p < .01$) and the use of understandable requirements specified by the users ($r_s = .22$, $p < .01$). Regarding the legacy support,

this question was related to the high levels of expertise ($r_s = .21, p < .01$), indicating that the complexity increased when training was required due to a lack of knowledge ($r_s = .22, p < .01$). This also increased the size of the team, with $r_s = .21, p < .01$.

ii *The system developed was of a complex nature (Complexity 2)*

For the second question regarding the complexity of the project, only one relationship could be found with the time of use of the SDM with $r_s = .21, p < .01$. This indicates that, as the system becomes more complex, the SDM will be used for a longer period in the organisation. The complexity of the system increased the size of the project ($r_s = .34, p < .01$) and the development time ($r_s = .31, p < .01$). The interaction of the system with other systems increases the complexity of the system, with $r_s = .31, p < .01$. The team size increases as the system becomes more complex ($r_s = .29, p < .01$).

iii *The problem complexity was very high (Complexity 3)*

The problem complexity indicated two relationships with the time of use of the SDM ($r_s = .16, p < .05$) and the tailoring of well-known SDMs ($r_s = .20, p < .05$). This indicates they will tailor some well-known SDMs while developing the system, using that SDM which is used longer in the organisation.

The complexity of the problem to be solved by the system increased the size of the project ($r_s = .29, p < .01$), the team size ($r_s = .25, p < .01$), and the training needed when knowledge was lacking ($r_s = .31, p < .01$). No relationships were found with the non-use of SDMs.

It can be concluded that the complexity of the problem does not influence the use or non-use of an SDM, but it does influence other characteristics that may lead to its use or non-use. The complexity influences the team size as well as the project size, and the legacy support influences the problem complexity.

6.2.10 Influence of the project cost limitations

This variable (section 4.4.4.5, Table 4-19) consisted of two questions used to determine the cost limitations of the project. The following table presents the correlation results of these variables' two questions towards the use of an SDM. The two questions used were:

- i *Cost limitations were present in the budget for the development of the system*
(Cost 1)
- ii *Limitations on the cost of the system suppressed the development of the system*
(Cost 2)

Table 6-6: Correlations of project cost limitations and the use of an SDM

Variable	Cost 1	Cost 2
Intensity of more familiar SDMs	.16	.08
Intensity of unfamiliar SDMs	.08	.11
Intensity if in-house SDMs	.02	.00
Intensity of Scrum	-.01	.05
Control provided as project management	-.01	.01
Decomposition of system development	.00	-.02
Time of use	.00	.01
Tailoring of other known SDMs	.02	.01
Tailoring of well-known SDMs	.10	.06
Tailoring of Agile SDMs	.17*	.18*
Strictness of use: adapted on project-to-project basis	-.02	-.13
Strictness of use: used as general guideline	-.13	-.18*
Strictness of use: a standard which is used rigorously	-.05	-.12

* $p < .05$, ** $p < .01$, *** $p < .001$

- i *Cost limitations were present in the budget for the development of the system*
(Cost 1)

Only one relationship could be found for this question towards the tailoring of agile SDMs ($r_s = .17$, $p < .05$). This indicates that as cost limitations were introduced in the project, the tailored agile SDMs were used.

The limitation of the cost had a rather small relationship with the development time ($r_s = .18, p < .05$), even though the requirements changed regularly ($r_s = .21, p < .01$). No relationship existed towards the non-use of the SDMs.

- ii *Limitations on the cost of the system suppressed the development of the system*
(Cost 2)

The second question indicated two relationships of statistical significance. The first is for this question on the tailoring of agile SDMs with $r_s = .18, p < .05$. The second relationship is a negative relationship towards the adoption of the SDM as a guideline ($r_s = -.18, p < .05$). This indicates that, with cost limitations, an SDM should not be used as a guideline.

The participants felt that the cost limitations did not suppress the development of the system (mean = 2.66, std. dev = 1.36), but the development time increased slightly when the cost limitation increased ($r_s = .17, p < .05$). The duration also increased with the cost limitations, with $r_s = .28, p < .01$. The cost limitations also indicated a relationship with the uncertainty in the organisation ($r_s = .21, p < .01$). When the users change the requirements regularly this also increases the cost limitations present ($r_s = .33, p < .01$).

From both the questions above it can be concluded that the cost limitations of a project have an influence on the tailoring of agile SDMs and the development time, being one of the characteristics to influence the selection and use of an SDM.

6.2.11 Influence of the project time limitations

The question in relation to the previous question (section 6.2.10) is on the time limitations present in the development project (section 4.4.4.5, Table 4-19). This variable consisted of two separate questions measuring time limitations. The table below presents the correlation results for these two questions towards the use of an SDM. These two questions were:

- i *Adequate time has been given for the development of the system* (Time 1)
- ii *The time assigned to each task has been enough* (Time 2)

Table 6-7: Correlations of project time limitations and the use of an SDM

Variable	Time 1	Time 2
Intensity of more familiar SDMs	-.07	.00
Intensity of unfamiliar SDMs	-.03	.00
Intensity if in-house SDMs	.25**	.08
Intensity of Scrum	.07	.13
Control provided as project management	.07	.12
Decomposition of system development	.05	.10
Time of use	.05	.02
Tailoring of other known SDMs	.10	.02
Tailoring of well-known SDMs	.02	.04
Tailoring of agile SDMs	.00	.11
Strictness of use: adapted on project-to-project basis	-.04	-.01
Strictness of use: used as general guideline	-.01	.00
Strictness of use: a standard which is used rigorously	-.02	-.03

* $p < .05$, ** $p < .01$, *** $p < .001$

The following table provide the results for the correlation towards the non-use of SDMs.

Table 6-8: Correlations of project time limitations and the non-use of an SDM

Variable	Time 1	Time 2
Non-adoption of SDMs	.06	.00
Reasons for non-use:	-	-
Environment not supporting	.54**	.31
Lack of experience	-.09	.08
Uncertainty	.15	.24
Long term commitment	-.25	-.07

* $p < .05$, ** $p < .01$, *** $p < .001$

i Adequate time has been given for the development of the system (Time 1)

This question had a positive relationship with the intense use of other in-house SDMs with $r_s = .25$, $p < .01$. This indicates that as the time increases for the development of the system, the in-house developed SDMs are used more intense.

For the relationships towards the non-use, a strong positive relationship has been found with the environment that is not supportive ($r_s = .54$, $p < .01$). This indicates that the less the environment is suited for the use of an SDM the less time will be available to actively develop the system.

Adequate time allocated had a positive relationship with the effective management of change ($r_s = .43$, $p < .01$) and unexpected changes ($r_s = .30$, $p < .01$). This question has statistically significant relationships, with all three questions related to the goals and vision ($r_s = .20$, $p < .01$, $r_s = .26$, $p < .01$, and $r_s = .24$, $p < .01$ respectively) of the project.

ii *The time assigned to each task has been enough* (Time 2)

This question did not indicate any relationships with the use or non-use of an SDM.

It is concluded that the time limitations had an influence on the selection and use of an SDM. This characteristic of time limitations to the project indicates the use of the Scrum SDM. Other influences include the change management and the goals and vision of the project.

6.2.12 Influence of the project change management

The variable related to the measuring of the change management of the project consisted of three questions (section 4.4.4.5, Table 4-19). These are

- i Changes requested to the system were managed effectively (CM 1).
- ii Unexpected crises and deviations were present in the development (CM 2).
- iii The unexpected crises and deviations were managed effectively (CM 3).

Correlation analysis has been performed on these three questions towards the variables towards the use of an SDM.

Table 6-9: Correlations of change management and the use of an SDM

Variable	CM 1	CM 2	CM 3
Intensity of more familiar SDMs	-.12	.01	-.09
Intensity of unfamiliar SDMs	-.03	.10	-.04
Intensity of in-house SDMs	.04	-.02	.00
Intensity of Scrum	-.02	-.05	.06
Control provided as project management	.10	.00	.01
Decomposition of system development	.11	-.12	-.03
Time of use	.19*	-.02	.13
Tailoring of other known SDMs	.06	.02	.05
Tailoring of well-known SDMs	.02	-.02	.04
Tailoring of agile SDMs	.02	.03	.00
Strictness of use: adapted on project-to-project basis	.10	.10	.06
Strictness of use: used as general guideline	.16	.07	.13
Strictness of use: a standard which is used rigorously	.08	.01	.07

* $p < .05$, ** $p < .01$, *** $p < .001$

The following table provide the results for the correlation towards the on-use of SDMs.

Table 6-10: Correlations of change management and the non-use of an SDM

Variable	CM 1	CM 2	CM 3
Non-adoption of SDMs	-.21	.11	-.08
Reasons for non-use:	-	-	-
Environment not supporting	.52**	-.26	.17
Lack of experience	-.12	.04	-.26
Uncertainty	.22	.16	-.12
Long term commitment	-.32	.24	-.18

* $p < .05$, ** $p < .01$, *** $p < .001$

From the tables above, it can be noted that only the first question indicated two relationships, one toward the use of an SDM and another one towards the non-use of an SDM. The first relationship is statistically significant towards the time of use ($r_s = .19$, $p < .05$), which indicates that the longer the SDM is used the more effectively it will be adopted to manage change. The other strong positive relationship is with an environment that is not supporting ($r_s = .52$, $p < .01$). This indicates that when a choice is made not to use an SDM the environment will not support changes but it will be managed effectively.

These questions indicated various relationships towards the goals and vision of the project, indicating that change management will influence the goals and vision set before the development begins on the project. A very strong relationship has been found between the change management and the well-planned installation plan ($r_s = .71$, $p < .01$), and the timely provision of information during the implementation ($r_s = .70$, $p < .01$).

It can be concluded that the change management influence the goals and vision, well-planned installation plan and the timely provision of information during implementation. It does not however indicate the use or non-use of an SDM.

6.2.13 Influence of the projects' development team

Four different questions were asked regarding the development team (section 4.4.4.5, Table 4-19), each to be discussed below for their relationships with other variables measuring the use of SDMs. These questions were:

- i *The development team had high experience in the use of the chosen SDM (Team 1)*
- ii *The project team was very cooperative during development (Team 2)*
- iii *The team was distributed over the country/world when the system was developed (Team 3)*
- iv *Team members communicated through technology while busy developing (Team 4)*

Table 6-11: Correlations of the development team and the use of an SDM

Variable	Team 1	Team 2	Team 3	Team 4
Intensity of more familiar SDMs	-.06	-.16	-.20*	-.06
Intensity of unfamiliar SDMs	.09	.04	-.05	.00
Intensity of in-house SDMs	.07	.03	.09	.08
Intensity of Scrum	.12	.09	.15	.17*
Control provided as project management	.15	.04	-.06	-.10
Decomposition of system development	.21*	.02	-.08	-.01
Time of use	.19*	.08	.15	.01
Tailoring of other known SDMs	.19*	.12	.07	.15
Tailoring of well-known SDMs	.23**	.12	.04	.19*
Tailoring of agile SDMs	.15	.14	.12	.23**
Strictness of use: adapted on project-to-project basis	.04	-.04	-.13	.00
Strictness of use: used as general guideline	.13	.09	-.10	-.01
Strictness of use: a standard which is used rigorously	.26**	.12	.13	.09

* $p < .05$, ** $p < .01$, *** $p < .001$

The following table provide the results for the correlation towards the on-use of SDMs.

Table 6-12: Correlations of the development team and the non-use of an SDM

Variable	Team 1	Team 2	Team 3	Team 4
Non-adoption of SDMs	.13	-.18	.09	-.03
Reasons for non-use:	-	-	-	-
Environment not supporting	.29	.19	.27	.22
Lack of experience	-.37*	-.31	-.05	.26
Uncertainty	.07	-.06	.26	.23
Long term commitment	-.20	-.10	-.30	-.03

* $p < .05$, ** $p < .01$, *** $p < .001$

i *The development team had high experience in the use of the chosen SDM*
(Team 1)

This question had a positive relationship towards the decomposition of the system, with $r_s = .21$, $p < .05$. Another, rather weak, relationship existed between the time of use of the SDM ($r_s = .19$, $p < .05$) as the team members obtained more experience in the use of the SDM the longer it was used. This question also indicated statistically significant relationships between the tailoring of well-known SDMs ($r_s = .23$, $p < .01$) and other known SDMs ($r_s = .19$, $p < .05$). This indicates that the more experience the developers has with an SDM the more they tailored other SDMs, maybe combining the tailored features into the SDM currently used. When the development team have high experience in the use, they tend to use the SDM as a rigorous standard they use throughout all the projects ($r_s = .26$, $p < .01$).

The experience of the developers indicated relationships between the tools and techniques used ($r_s = .28$, $p < .01$ and $r_s = .38$, $p < .01$ respectively). The legacy support also indicated strong relationships between (LS 1) $r_s = .40$, $p < .01$, (LS 2) $r_s = .44$, $p < .01$, and (LS 3) $r_s = .25$, $p < .01$ respectively. These relationships were also evident in the other questions in this variable.

When no SDM was used, a negative relationship was found towards the reason that a lack of experience motivate the choice an SDM are not used ($r_s = -.37$, $p < .05$). This indicates that the less experience the development team has in the SDM the more this will contribute to it not being used, indicating that the development team will then tend to use an SDM.

ii *The project team was very cooperative during development* (Team 2)

It should be noted that this question did not indicate any relationships between other variables used to measure the use or non-use of an SDM. Relationships exist with the tools and techniques and the legacy support provided (as stated above), together with the timely provision of information ($r_s = .77$, $p < .01$).

iii *The team was distributed over the country/world when the system was developed*
(Team 3)

This question indicated only one relationship with the intense use of familiar SDMs ($r_s = -.20, p < .05$). That this was negative indicates that the more intensely familiar SDMs are used the closer the development team should be while developing the system.

iv *Team members communicated through technology while busy developing (Team 4)*

A positive relationship with the intense use of the Scrum SDM ($r_s = .17, p < .05$) and the tailoring of agile SDM ($r_s = .23, p < .01$) indicates that the use of technology for communication increased the intense use of a tailored agile SDM. Another small positive relationship also exists with the tailoring of well-known SDMs ($r_s = .19, p < .05$).

This section concludes that the development team influences the tailoring of SDMs, as well as the tools and techniques used, and the legacy support provided to the team. The development team directly influence the selection and use of an SDM.

6.2.14 Influence of the projects’ tools and techniques

Tools and techniques are part of SDMs, and two questions were asked, one for tools and one for techniques (section 4.4.4.5, Table 4-19). These two questions include:

- i *Appropriate development tools (CASE tools) were used for development (TT 1)*
- ii *Appropriate development techniques were used (TT 2)*

The following table presents the results obtained from the correlation analysis.

Table 6-13: Correlations of the tools and techniques and the use of an SDM

Variable	TT 1	TT 2
Intensity of more familiar SDMs	.00	-.01
Intensity of unfamiliar SDMs	.03	-.06
Intensity of in-house SDMs	-.12	-.11
Intensity of Scrum	.12	.17
Control provided as project management	.23**	.23**
Decomposition of system development	.27**	.21*
Time of use	.20**	.22**

Tailoring of other known SDMs	.20**	.11
Tailoring of well-known SDMs	.25**	.16*
Tailoring of agile SDMs	.09	.12
Strictness of use: adapted on project-to-project basis	.06	.12
Strictness of use: used as general guideline	.15	.12
Strictness of use: a standard with is used rigorously	.26**	.14

* $p < .05$, ** $p < .01$, *** $p < .001$

Correlations analysis has also been performed on the variables used to measure the non-use of SDMs, and are reported in the following table:

Table 6-14: Correlations of the tools and techniques and the non-use of an SDM

Variable	TT 1	TT 2
Non-adoption of SDMs	.08	.02
Reasons for non-use:	-	-
Environment not supporting	.21	.00
Lack of experience	.07	-.19
Uncertainty	-.16	-.11
Long term commitment	-.14	.32

i *Appropriate development tools (CASE tools) were used for development (TT 1)*

Participants felt that appropriate CASE tools were used to some extent. Statistically significance relationships have been found between the support the SDM provided as project management ($r_s = .23$, $p < .01$) and the decomposition of the system ($r_s = .27$, $p < .01$), indicating that the use of CASE tools will increase the SDM's contribution to the development of the system. The same relationship has been found with the time the SDM is used ($r_s = .20$, $p < .01$), indicating that the use of CASE tools will influence how long a SDM will be used. SDMs are also tailored, whereby the well-known SDMs ($r_s = .25$, $p < .01$) has a stronger relationship than the tailoring of other SDMs ($r_s = .20$, $p < .01$). It should also be noted that the more CASE tools are used the more the SDM should be adopted as a standard to be followed rigorously ($r_s = .26$, $p < .01$).

The gender of the participant had an influence on the use of CASE tools ($r_s = .21$, $p < .01$), which indicates that women are more likely to use CASE tools than men. No relationships were found with the non-use of SDMs.

ii *Appropriate development techniques were used (TT 2)*

The use of techniques reports relationships similar to the use of CASE tools where the use of techniques influence the time the SDM will be used ($r_s = .22$, $p < .01$). The same relationship exists towards the control the SDM provides as project management ($r_s = .23$, $p < .01$), with a weaker relationship towards the decomposition of the system ($r_s = .21$, $p < .05$). One relationship was found with the tailoring of well-known SDMs with $r_s = .16$, $p < .01$.

The use of techniques is influenced by the increase in the problem complexity ($r_s = .31$, $p < .01$). No relationships have been found with the non-use of SDMs.

This section concludes that the tools and techniques influence the tailoring of well-known SDMs, the control the SDM provides as project management, the decomposition of the system, as well as the time of use of the SDM.

6.2.15 Influence of the project requirements

Three questions were presented to the participants (section 4.4.4.5, Table 4-19) regarding the requirements from the users in their latest project. Table 6-15 reports the correlations for each of these three questions (Req 1, Req 2 and Req 3):

- i *Users changed the requirements of the system regularly during the project (Req 1)*
- ii *The requirements from users were understandable to the developers (Req 2)*
- iii *Conflicting user requirements were present during the project (Req 3)*

Table 6-16 on the other hand reports the correlations for the variables used to measure the non-use of SDMs.

- i *Users changed the requirements of the system regularly during the project (Req 1)*

This question did not indicate any relationship with the use of SDMs. Two strong relationships have been found towards the non-use of an SDM. The relationship towards the non-adoption of SDMs ($r_s = .46, p < .05$) indicates that the regular change of requirements as to why the IS department did not adopt SDMs. The other relationship ($r_s = .40, p < .05$) showed that the reason for not adopting an SDM was knowledge that adoption would be a long-term commitment.

As the users changed the requirements regularly, which had an influence on the cost limitations present in the project ($r_s = .21, p < .01$ and $r_s = .33, p < .01$ respectively). The changing of requirements had negative relationships with the goals and vision of the project: (GV 1) $r_s = -.23, p < .01$ (GV 2) $r_s = -.31, p < .01$, and (GV 3) $r_s = -.18, p < .01$. This indicates that the goals and vision fade away as the requirements continually change.

ii *The requirements from users were understandable to the developers (Req 2)*

Only one relationship was found in Table 6-15. As the requirements were more understandable to the developers, the more decomposed the system developed ($r_s = .19, p < .05$). The changing of requirements had found positive relationships with the goals and vision of the project: (GV 1) $r_s = .42, p < .01$ (GV 2) $r_s = .40, p < .01$, and (GV 3) $r_s = .38, p < .01$, which indicates that the goals and vision become clearer as the requirements are more understandable to the developers. No other relationships were found in Table 6-15 or 6-16.

iii *Conflicting user requirements were present during the project (Req 3)*

The question showed relationships between the intense use of more familiar SDMs ($r_s = .18, p < .05$) and unfamiliar SDMs ($r_s = .21, p < .05$). Regarding the reasons not to use an SDM, the long-term commitment showed a strong relationship with $r_s = .48, p < .01$. This indicates that as the requirements become more conflictive the long-term commitment is preventing the use of an SDM. As the users changed the requirements regularly, causing requirement to be in conflict, this had an influence on the cost limitations present in the project ($r_s = .20, p < .01$ and $r_s = .30, p < .01$ respectively).

Table 6-15: Correlations of project requirements, goals and vision, legacy support and maintenance and the use of an SDM

Variable	Req 1	Req 2	Req 3	GV 1	GV 2	GV 3	LS 1	LS 2	LS 3	MT
Intensity of more familiar SDMs	.11	-.15	.18*	-.13	.00	.01	.08	.06	-.15	.15
Intensity of unfamiliar SDMs	.07	-.03	.21*	.03	.14	.08	.21*	.18*	.01	.25**
Intensity of in-house SDMs	-.02	.04	-.05	.00	-.07	-.03	.11	.14	.00	-.05
Intensity of Scrum	.09	.01	.04	.10	.18*	.16	-.06	.09	.12	.11
Control provided as PMP	.04	.14	-.04	.14	.21*	.24**	.11	.30**	.14	.14
Decomposition of system development	-.03	.19*	-.08	.09	.13	.18*	.16	.23**	-.02	.10
Time of use	-.02	.13	.01	.16*	.08	.07	.19*	.19*	.22**	.22**
Tailoring of other known SDMs	.04	-.14	.07	.05	.11	.15	.06	.04	-.04	.12
Tailoring of well-known SDMs	.11	-.01	.10	.14	.13	.17*	.14	.12	.07	.26**
Tailoring of agile SDMs	.10	-.04	.09	.07	.10	.12	-.03	.03	.10	.05
Strictness of use: adapted on project-to-project basis	.06	-.05	-.09	-.09	-.02	.00	.05	.05	.01	.05
Strictness of use: used as general guideline	-.06	-.04	-.04	-.06	-.06	-.08	.12	-.12	-.04	-.11
Strictness of use: a standard which is used rigorously	.06	.03	-.02	.03	.03	-.03	.23	.09	-.05	.12

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 6-16: Correlations of project requirements, goals and vision, legacy support and maintenance and the non-use of an SDM

Variable	Req 1	Req 2	Req 3	GV 1	GV 2	GV 3	LS 1	LS 2	LS 3	MT
Non-adoption of SDMs	.46*	-.13	.11	-.41*	-.44*	-.37*	-.07	-.04	-.19	-.08
Reasons for non-use:	-	-	-	-	-	-	-	-	-	-
Environment not supporting	-.09	.10	.02	.34	.35	.42*	-.04	-.09	.25	.42*
Lack of experience	-.08	-.05	-.04	.22	.24	.18	-.14	-.27	-.06	-.02
Uncertainty	.33	.29	.32	.01	-.05	.06	.06	-.09	.08	-.01
Long term commitment	.40*	.04	.48**	.03	.02	-.09	.20	-.01	-.07	-.24

* $p < .05$, ** $p < .01$, *** $p < .001$

This concludes that the requirements of the project are related to the cost limitations and the goals and vision of the project. The requirements do not influence the use or non-use of SDMs.

6.2.16 Influence of the projects' goals and vision

The participants in the study feel rather good about the goals and vision of the projects, where means of almost 4 (out of 5) have been calculated for the three questions regarding the goals and visions (section 4.4.4.5, Table 4-19):

- i *Clear goals was set before and was evident during the development (GV 1)*
- ii *A clear vision and clear objectives was present on the project (GV 2)*
- iii *The goals and vision was mutually agreed upon between the team and all the stakeholders (GV 3)*

These three questions will now be discussed.

- i *Clear goals was set before and was evident during the development (GV 1)*

This question presented only one relationship in Table 6-15 towards the time of use of the SDM with $r_s = .16$, $p < .05$. This indicates the longer the SDM is used the more goals will be set before a developing project. No other relationships were found towards the use of an SDM. The goals and vision influenced the recognition of the complexity of the system ($r_s = .39$, $p < .01$), as well as a well-defined maintenance plan ($r_s = .39$, $p < .01$).

Table 6-16 indicated the relationship that the setting of goals before the development decreased the reason not to adopt an SDM. This relationship is strong, with $r_s = .41$, $p < .05$. No other relationships were found towards the non-use of SDMs.

- ii *A clear vision and clear objectives was present on the project (GV 2)*

A relationship indicated that as a vision and objectives were present the more intensely the Scrum SDM was used ($r_s = .18$, $p < .05$). The SDM also provided control as project management ($r_s = .21$, $p < .05$). The more there are goals and a vision in development, the stronger the reason for not adopting an SDM becomes, and the IS department did not

consider the use of an SDM ($r_s = -.44, p < .05$). Perhaps the organisation followed its own methods, and did not recognize it as an SDM. The clear vision and objectives influenced the recognition of the complexity of the system ($r_s = .40, p < .01$), as well as a well-defined maintenance plan ($r_s = .44, p < .01$).

iii *The goals and vision was mutually agreed upon between the team and all the stakeholders (GV 3)*

When the goals and vision were agreed upon, the SDM provided control as project management ($r_s = .24, p < .01$). This also contributed to the decomposition of the system ($r_s = .18, p < .05$) while tailoring well-known SDMs to use ($r_s = .17, p < .05$). The mutual agreement on the goals and vision influenced the recognition of the complexity of the system ($r_s = .35, p < .01$), as well as a well-defined maintenance plan ($r_s = .36, p < .01$).

The more there the goals and vision were agreed upon, the stronger the reason for not adopting an SDM, and the IS department did not consider the use of an SDM ($r_s = -.37, p < .05$). Perhaps the organisation follows their own methods, and does not recognize it as an SDM. They also tend to indicate that the environment is not supporting the use of an SDM ($r_s = .42, p < .05$).

It could be concluded that having goals and a vision will influence the use of an SDM, as the presence thereof has a negative influence on the reason not to adopt an SDM. The goals and vision influence the problem complexity and the maintenance plan.

6.2.17 Influence of the projects' legacy support

The following three questions have been used in the questionnaire regarding the legacy support:

i *The system involved technologies with which the developers were familiar with (LS 1)*

ii *The development team had high levels of expertise in development (LS 2)*

iii *When knowledge lacked, training was given to gain the appropriate knowledge (LS 3)*

The participants seem to feel quite good regarding the use of their expertise ($ME = 4.02$, $SE = 1.08$) and technology ($ME = 4.8$, $SE = 1.00$) for development (section 4.4.4.5, Table 4-19). They do however feel that when they lacked knowledge insufficient training was provided ($ME = 3.17$, $SE = 1.37$).

i *The system involved technologies with which the developers were familiar with*
(LS 1)

The question indicated a more intense use of unfamiliar SDMs ($r_s = .21$, $p < .05$) but also the time the SDM was used ($r_s = .19$, $p < .05$). The inclusion and use of technologies influenced the development teams' high experience ($r_s = .40$, $p < .01$) and the cooperativeness ($r_s = .20$, $p < .01$). No other relationships could be found or with the non-use of SDMs (Table 6-17).

ii *The development team had high levels of expertise in development* (LS 2)

This question indicated the same relationships as the previous question. Unfamiliar SDMs are used more intensely ($r_s = .18$, $p < .05$) when the developers had high levels of expertise, and the time of use increases ($r_s = .19$, $p < .05$). The expertise of the developers also indicated relationships with the support the SDM provided as project management ($r_s = .30$, $p < .01$) and the decomposition of the system ($r_s = .23$, $p < .01$). These levels of high experience influenced the development teams' high level of experience ($r_s = .44$, $p < .01$) and the cooperativeness ($r_s = .21$, $p < .01$). No other relationships could be found.

iii *When knowledge lacked, training was given to gain the appropriate knowledge*
(LS 3)

The question only indicates a statistically significant relationship with the time the SDM is used ($r_s = .22$, $p < .01$). The inclusion of training when knowledge lacking influenced the development teams' high experience ($r_s = .25$, $p < .01$) and the cooperativeness ($r_s = .25$, $p < .01$). This training also indicated a positive relationship to the well-defined maintenance plan ($r_s = .42$, $p < .01$). No other relationships could be found.

The legacy support influences the time of use of an SDM, as well as the development team, and are not regarded as one to influence the selection and use of an SDM.

6.2.18 Influence of the project maintenance plan

This variable was measured using one question (section 4.4.4.5, Table 4-19). Table 6-15 indicates the relationships found with the variables used to measure the use of SDMs.

The well-defined maintenance plan had an influence on the intense use of unfamiliar SDMs ($r_s = .25$, $p < .01$) and the tailoring of well-known SDMs ($r_s = .26$, $p < .01$). The maintenance plan was also influenced by the time of use of the SDM with $r_s = .22$, $p < .01$ which may indicate that the time the SDM is used and the expertise gained will create a well-defined maintenance plan specific for the system developed.

Table 6-16 indicates that the well-defined maintenance plan is influenced by the environment not supported ($r_s = .42$, $p < .05$), indicating that a maintenance plan may influence the non-use of an SDM if the developers has the needed expertise.

The implementation of a well-defined maintenance plan influences the use of unfamiliar SDMs and the tailoring of well-known SDMs, as well as the time of use of these SDMs. The maintenance plan can also influence the decision not to use an SDM. This one influences the selection and use of an SDM.

6.2.19 Influence of the project duration

The duration of the project is not the same as the time for development (section 6.2.5). The duration of the project has been measured using the same timeframes presented for the development time, when more than 80% of all projects had a duration of less than two years, more than 60% thereof having a duration of less than one year (section 4.4.4.9, Table 4-23).

The following table presents the results obtained through correlation analysis towards the variables used to measure the use of an SDM.

Table 6-17: Correlations of project duration and size and the use of an SDM

Variable	Duration	Size
Use of an SDM	-.04	-.24**
Intensity of more familiar SDMs	.10	.07
Intensity of unfamiliar SDMs	.13	.19*
Intensity of in-house SDMs	-.04	.10
Intensity of Scrum	.03	-.04
Control provided as PMP	.03	-.01
Decomposition of system development	-.04	.01
Time of use	.13	.22**
Tailoring of other known SDMs	-.03	.02
Tailoring of well-known SDMs	.10	.10
Tailoring of agile SDMs	.01	.11
Strictness of use: adapted on project-to-project basis	-.07	.00
Strictness of use: used as general guideline	-.15	-.18*
Strictness of use: a standard which is used rigorously	.01	-.10

* $p < .05$, ** $p < .01$, *** $p < .001$

The table above indicates that the duration of the project does not have any relationship with the use of an SDM. The following table indicates the relationship to the variables used to measure the non-use of an SDM.

Table 6-18: Correlations of project duration and size and the non-use of an SDM

Variable	Duration	Size
Non-adoption of SDMs	-.17	.20
Reasons for non-use:	-	-
Environment not supporting	-.31	-.29
Lack of experience	.12	-.17
Uncertainty	-.11	-.39*
Long term commitment	.01	-.35

* $p < .05$, ** $p < .01$, *** $p < .001$

This table also indicates that the duration of a project does not have any relationship with the non-use of an SDM. Therefore, it can be concluded that the duration of the project does not contribute to the decision to use or not to use an SDM.

6.2.20 Influence of the projects' team size

The size of the team is something other than the size of the project. The size of the team has been measured through people (section 4.4.4.9, Table 4-24). More than half of the teams had fewer than seven people, being actively part of the development of the system and applying the SDM that is used (or just developing if an SDM was not used).

Table 6-17 indicates the relationships found through correlation analysis. The size of the team had a negative (and rather weak) relationship with using the SDM as a guideline ($r_s = -.18$, $p < .05$). This indicates that the larger the team gets the less the SDM should be only a guideline. No relationship exists with adapting the SDM on a project-by-project nature, but this was not statistically significant. A positive relationship of statistical significance has been found towards the time the SDM has been used with $r_s = .22$ $p < .01$. As unfamiliar SDMs are used more intense the size of the team also increases slightly ($r_s = .19$, $p < .05$).

Measuring the non-use of an SDM (Table 6-18), a relationship is found of statistical significance which are moderate. As the size of the team increases the less uncertainty is evident in the system, $r_s = -.38$, $p < .05$. No other relationships were found. This could be explained that when a decision is made not to use an SDM the uncertainty will decrease as the team size increases.

This section concludes that the size of the team does not influence the use of an SDM, but the correlation towards the use of an SDM indicates that the team size has an influence on the use of an SDM. It does however influence the size related to the time the SDM are used, the use of the SDM as a guideline and when no SDM is used, to the uncertainty of the system. The size is however, dependent on the intense use of unfamiliar SDMs.

6.3 SUMMARY

This chapter discussed the characteristics of a project level that has an influence on the selection of an SDM. Analysis has been used to determine the contribution of these characteristics towards the use of an SDM. The following conclusions have been drawn:

- The size of the project has an influence on the use of an SDM, as well as the tailoring thereof. The size also indicates how the SDM should be adopted, in this case, as a standard (or a general guideline).
- It cannot be concluded that the criticality had an influence on the selection and use of an SDM. This characteristic had an influence on the size of the project, the time the SDM was used, and the criticality of the system.
- The nature of the project does not indicate the use or non-use of an SDM. However, it does indicate whether timely provision of information is needed, and the use of technology for communication purposes. The development time also increased with the nature of the project.
- The planned future of the system does not contribute to the selection or use of an SDM. It does however influence the decomposition of the system and the time the SDM will be used.
- The development time does not contribute to the selection and use of an SDM, but that it does contribute to other characteristics, such as the time of use, the complexity, the efficient process, and others.
- The type of DB used will influence the intensity and tailoring of SDMs.
- The external interaction of the system does not indicate the use or non-use of an SDM, but that it does influence the decomposition and complexity of the system and the size and criticality of the project.
- The platform does indicate a selection and use of an SDM. It does also influence the installation/adoption plan.
- The complexity of the problem does not influence the use or non-use of an SDM, but it does influence other characteristics that may lead to its use or non-use. The

complexity influences the team size as well as the project size, and the legacy support influences the problem complexity.

- The cost limitations of a project have an influence on the tailoring of agile SDMs and the development time, being one of the characteristics to influence the selection and use of an SDM.
- The time limitations had an influence on the selection and use of an SDM. This characteristic of time limitations to the project indicates the use of the Scrum SDM. Other influences include the change management and the goals and vision of the project.
- The change management influence the goals and vision, well-planned installation plan and the timely provision of information during implementation. It does not however indicate the use or non-use of an SDM.
- The development team influences the tailoring of SDMs, as well as the tools and techniques used, and the legacy support provided to the team. The development team directly influence the selection and use of an SDM.
- The tools and techniques influence the tailoring of well-known SDMs, the control the SDM provides as project management, the decomposition of the system, as well as the time of use of the SDM.
- The requirements of the project are related to the cost limitations and the goals and vision of the project. The requirements do not influence the use or non-use of SDMs.
- Having goals and a vision will influence the use of an SDM, as the presence thereof has a negative influence on the reason not to adopt an SDM. The goals and vision influence the problem complexity and the maintenance plan.
- The legacy support influences the time of use of an SDM, as well as the development team, and are not regarded as one to influence the selection and use of an SDM.
- The implementation of a well-defined maintenance plan influences the use of unfamiliar SDMs and the tailoring of well-known SDMs, as well as the time of use of

these SDMs. The maintenance plan can also influence the decision not to use an SDM. This one influences the selection and use of an SDM.

- The duration of the project does not contribute to the decision to use or not to use an SDM.
- The size of the team does not influence the use of an SDM, but the correlation towards the use of an SDM indicates that the team size has an influence on the use of an SDM. It does however influence the size related to the time the SDM are used, the use of the SDM as a guideline and when no SDM is used, to the uncertainty of the system. The size is however, dependent on the intense use of unfamiliar SDMs.

The next chapter will discuss the characteristics that may have an influence on the selection of an SDM on an individual level.

CHAPTER 7

RESULTS OF THE INDIVIDUAL LEVEL

7.1 INTRODUCTION

This chapter will be devoted to the discussion of the results on the individual level. Firstly, the characteristics investigated will be mentioned, followed by discussion of one of the research goals stated in Chapter 1 (section 1.3). These research goals are:

- i identify the characteristics influencing the selection of an SDM on an organisational level.
- ii identify the characteristics influencing the selection of an SDM on a project level.
- iii identify the characteristics influencing the selection of an SDM on an individual level.**
- iv develop the theoretical framework, based on the evaluation.

This chapter will focus on the third goal above (iii) and will be discussed in the following sections.

7.2 CHARACTERISTICS INFLUENCING THE SELECTION OF AN SDM ON AN INDIVIDUAL LEVEL

The third objective of this research is the identification of the characteristics influencing the selection of an SDM on an individual level. Referring back to the conceptual model constructed in Chapter 3 (section 3.7.5.1, Figure 3-2), five characteristics were included, that is, the individuals' (1) gender, (2) age, (3) job category (4) qualification and (5) personal experience of the use of SDMs. The following sections will address each of these characteristics.

7.2.1 Influence of the individuals' gender

The gender of respondents was the first question in the questionnaire. The males represented 87% of the respondents, while the females represented 13% of the respondents (section 4.3.1). On average, the female participants (13%) used more familiar SDMs, and more intensely (section 4.4.1), with a mean of about 4.00 (out of 10), and a standard deviation of 2.34. The male participants (87%) had a slightly lower mean of 3.74 (with a standard deviation of 2.13). This is also true when comparing females ($M = 2.16$, $SE = 2.51$) and males ($M = 1.81$, $SE = 1.59$) for the unfamiliar SDMs.

A t -test has been performed to determine if the difference between these two means are of meaning. The following table presents the results of the t -test conducted on the intensity of SDMs used (section 4.4.1), based on the gender of the respondents.

Table 7-1: t -Test results: Comparing males and females on intensity of more familiar SDM use

Variable	N	Mean	SD	t	df	p
Males	116	3.74	2.13	-.485	132	.628
Females	18	4.01	2.34			

These differences were not statistically significant with $t(132) = -.485$, $p > .05$. A small practical effect was reported with $d = 0.11$ but is of no meaning, as no statistical significance exists.

Table 7-2: t -Test results: Comparing males and females on intensity of unfamiliar SDMs

Variable	N	Mean	SD	t	df	p
Males	116	1.81	1.59	-.799	132	.425
Females	18	2.16	2.51			

Table 7-2 reports that there exists no statistical significant difference between the intensity with which the males use unfamiliar SDMs against the intensity of females using unfamiliar SDMs ($t(132) = -.799$, $p > .05$). A small practical effect was also evident in

that gender does not contribute to the use (or intensity) of certain types of SDMs ($d = 0.14$). No statistical significance could be found in the difference of tailoring well-known SDMs ($t(164) = -1.201, p > .05$), other known SDMs ($t(164) = -.418, p > .05$), or agile SDMs ($t(164) = -.113, p > .05$) between male and female respondents. The gender of the individual does not contribute to the tailoring of SDMs.

The following table represents the results from the t -test for the support provided by the SDM as a control technology (section 4.4.4.1).

Table 7-3: t -Test results: Comparing males and females on perceived support provided by the SDM as project management

Variable	N	Mean	SD	t	df	p
SDM control as Project Management Process						
Males	116	3.82	.74	-2.744	130	.007**
Females	16	4.36	.68			
Decomposition of system development						
Males	116	3.90	.80	-2.419	130	.017*
Females	16	4.41	.61			

* $p < .05$, ** $p < .01$, *** $p < .001$

It can be noted that both test displayed statistical significance when comparing the means reported by both males and females for the SDM control as Project Management ($p < .001$) and the decomposition of system development ($p < .01$). The effect sizes for both tests indicate a small practical effect with $r = 0.23$ and $r = 0.21$ respectively.

Table 7-4 reports the results from the correlation analysis using the variables of an individual against the variables used to measure the use of an SDM.

Table 7-4: Correlations of the characteristics of an individual and the use of an SDM

Variable	Gender	Age	Job category	Highest qualification	Personal experience
Intensity of more familiar SDMs	-.03	-.19*	.03	.08	-.22*
Intensity of unfamiliar SDMs	-.04	-.07	-.05	.04	-.14
Intensity of in-house SDMs	-.07	.04	.01	.17	-.05
Intensity of Scrum	-.13	-.21*	.13	-.13	-.12
Control provided as PMP	.24**	-.09	.15	-.14	-.04
Decomposition of system development	.21*	-.08	.22*	-.13	-.10
Time of use	.03	.13	-.15	.06	.15
Tailoring of other known SDMs	.84	-.11	.03	-.05	-.18*
Tailoring of well-known SDMs	.03	-.11	-.05	-.11	-.16*
Tailoring of agile SDMs	.02	-.08	-.10	-.02	.00
Strictness of use: adapted on project-to-project basis	-.01	-.12	-.09	-.16	-.11
Strictness of use: used as general guideline	.12	-.14	-.02	-.12	-.10
Strictness of use: a standard with is used rigorously	.15	-.03	.09	-.11	-.08

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 7-5: Correlations of the characteristics of an individual and the non-use of an SDM

Variable	Gender	Age	Job category	Highest qualification	Personal experience
Non-adoption of SDMs	-.25	.19	-.03	-.34	.05
Reasons for non-use:					
Environment not supporting	.23	-.31	.38*	.28	-.26
Lack of experience	.23	-.20	.18	.00	-.13
Uncertainty	-.14	.01	.23	.45*	-.11
Long term commitment	-.05	-.18	.13	.11	-.33

* $p < .05$, ** $p < .01$, *** $p < .001$

The gender of the participants indicated positive relationships with the SDM as project management ($r_s = .24, p < .01$) and the decomposition of the system ($r_s = .21, p < .01$). Although these relationships are weak they are still statistically significant. No other significant relationships could be found.

The following paragraphs of this section will report on the projects that did not use an SDM. A *t*-test could not be performed on the question regarding the reasons for not using an SDM. The group of females were not sufficiently represented, as only 9% females were not using an SDM from the 19% of overall projects.

From Table 7-5, no significant relationships could be found for the gender of the participants towards the variables used to measure non-use of an SDM.

From the above, it can be concluded that the gender of the individual does contribute to the selection and use of an SDM, as it contributes to the perception of how the SDM will provide support as project management, and how decomposed the system will most likely be.

7.2.2 Influence of the individuals' age

The age of the respondents were measured with five predefined intervals of younger than 18 years, 18-25, 26-35, 36-45, and more than 46 years, where the majority of the respondents indicated an age between 26 and 35 (section 4.3.2). No respondents were younger than 18 years.

Table 7-6: ANOVA results for the age against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	2. 4.84 3. 4.06 4. 2.49 5. 3.74	3,130	7.280***
Intensity of unfamiliar SDMs	2. 2.67 3. 1.78 4. 1.17 5. 2.61	3,130	4.631**

SDM control as PMP	2. 4.11 3. 3.88 4. 3.72 5. 4.04	3,128	1.430
Decomposition of system development	2. 4.09 3. 3.97 4. 3.79 5. 4.14	3,128	.858
Tailoring of other known SDMs	2. 2.01 3. 1.62 4. 1.55 5. 2.30	3,162	3.083'
Tailoring of well-known SDMs	2. 2.93 3. 2.70 4. 2.17 5. 3.44	3,162	5.392**
Tailoring of Agile SDMs	2. 2.90 3. 3.01 4. 2.68 5. 2.54	3,162	.995

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

The analysis on the age of the respondents towards the intense use of methodologies found a significant effect with more familiar SDMs ($F(3,130) = 7.280$, $p < .001$). Studying the responses between the age group of 19 – 25 against the age group of 36 – 45, a large practical effect has been found ($d = 0.86$), as well as the age group of 26 – 35 against the age group of 36 – 45 ($d = 0.76$). A rather medium significant effect has been found for the age group of 36 – 45 and the age group of 46 and older ($d = 0.59$). This indicates that the age of the individual indirectly influences how intense they will follow an SDM.

It was also found statistically significant for the age of an individual towards the tailoring of well-known SDMs, $F(3,162) = 5.392$, $p < .01$. Medium practical effects were found between organisations with the ages of 19-25 and 36-45 ($d = 0.65$) towards the tailoring of these well-known SDMs. A very large ($d = 1.12$) practical effect was found between the tailoring of well-known SDMs in organisations with an age of 36-45 and those who were older than 46.

The age of the respondents against the unfamiliar SDMs had a significant effect ($F(3,130) = 4.631$, $p < .01$). A medium practical effect has been found between the age

group of 19 – 25 and the age group of 36 – 45 ($d = 0.57$), as well as the age group of 36 – 45 and the age group of 46 and older ($d = 0.62$).

The results from the correlation analysis are presented in Table 7-4. The age of the participants presents a negative relationship with the intense use of familiar SDMs ($r_s = -.19, p < .05$), indicating that as the individual are more advanced in age the less intensely they use the more familiar SDMs. A further negative relationship is founded on the intense use of the Scrum SDM ($r_s = -.21, p < .05$), indicating that the older the participant the less intensely will they use the Scrum SDM.

The following table presents the results of the variables used to measure the non-use of an SDM. It should be noted that too few participants represented age categories from 36 years and older (categories 4 and 5 in Table 7-7).

Table 7-7: ANOVA results for the age against the non-use of SDMs

Variable	Mean	df	F
Environment not supporting	2. 3.42 3. 2.73 4. 2.33 5. 3.50	3,28	2.281
Lack of experience	2. 3.08 3. 3.03 4. 2.17 5. 2.75	3,28	.675
Uncertainty	2. 3.21 3. 3.08 4. 3.17 5. 3.38	3,28	.089'
Long term commitment	2. 3.71 3. 3.53 4. 3.00 5. 3.50	3,28	.421

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

No significant results could be found to indicate that the age of an individual contributed to the non-usage of SDMs. Regarding the results of the correlation analysis presented in Table 7-5, no significant relationships could be found in which the age of the participant contributed to the variables used to measure the non-use of SDMs.

This section has found that the age of the individual contributes directly to the use of SDMs. As the age of the individual increases, they will use familiar SDMs less intensely, as they will tailor it more. As the age decreases, the intensity of use of SDMs also decreases.

7.2.3 Influence of the individuals’ job category

A predefined list of job categories was presented to respondents (section 4.3.3) but no order was present in the list of job categories. For this reason, correlation analysis could not be of value for determining if the job category made any contribution to the adoption and use of an SDM, or the non-use thereof.

The category labelled *Analyst* has not been sufficiently represented, and was thus excluded from the following analysis on this variable. The following table represents the results from the ANOVA analysis towards the use of SDMs.

Table 7-8: ANOVA results for the job category against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 3.10 2. 3.58 3. 3.96	2,112	1.045
Intensity of unfamiliar SDMs	1. 1.38 2. 1.68 3. 2.02	2,112	.942
SDM control as Project Management	1. 3.66 2. 3.70 3. 3.89	2,111	.926'
Decomposition of system development	1. 3.79 2. 3.61 3. 4.00	2,111	2.254
Tailoring of other known SDMs	1. 2.00 2. 1.87 3. 1.68	2,139	.902
Tailoring of well-known SDMs	1. 2.81 2. 2.76 3. 2.60	2,139	.376
Tailoring of Agile SDMs	1. 2.91 2. 3.20 3. 2.80	2,139	1.033

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

None of the variables used to measure the use of an SDM has been found to be of any statistical significance. One of the variables violated the assumption of homogeneity (SDM control as project management), and could not be used any further in this analysis. It can therefore, be concluded that the job category does not contribute to the selection and use of an SDM.

The following table presents the results of the variables used to measure the non-use of an SDM.

Table 7-9: ANOVA results for the age against the non-use of SDMs

Variable	Mean	df	F
Environment not supporting	1. 2.17 2. 3.25 3. 2.98	2,24	1.254'
Lack of experience	1. 2.67 2. 3.25 3. 2.73	2,24	.253'
Uncertainty	1. 3.08 2. 3.00 3. 3.08	2,24	.007'
Long term commitment	1. 3.17 2. 3.75 3. 3.43	2,24	.207'

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

All the variables included in the measuring of non-use have been disregarded as they violated the assumptions of homogeneity. An insufficient number of participants were present in the categories of an Information System Manager (ISM) and the project manager/leader category, and not using an SDM. It can therefore, be concluded that, for this study, the job category of the individual does not contribute to the non-use of an SDM.

This section concluded that the job category does not influence either the use or non-use of an SDM.

7.2.4 Influence of the individuals' qualifications

Section 4.3.3, Table 4-3, presents the qualifications of the individuals, which were set up using an order for the highest qualification (that of a doctoral degree) having the highest code assigned to it, and the lowest qualification the lowest code.

ANOVA analysis was conducted on this variable towards the following ones reported in Table 7-10:

Table 7-10: ANOVA results for the highest qualification against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	2. 3.63 3. 4.57 4. 3.54 5. 3.35	3,122	2.348
Intensity of unfamiliar SDMs	2. 2.20 3. 2.16 4. 1.50 5. 1.60	3,122	1.336
SDM control as PMP	2. 3.98 3. 3.85 4. 3.92 5. 3.73	3,120	.580
Decomposition of system development	2. 3.93 3. 4.09 4. 3.82 5. 3.85	3,120	.832
Tailoring of other known SDMs	2. 1.78 3. 2.02 4. 1.51 5. 1.57	3,152	2.312'
Tailoring of well-known SDMs	2. 2.72 3. 3.01 4. 2.56 5. 2.36	3,152	2.587
Tailoring of Agile SDMs	2. 2.71 3. 3.32 4. 2.72 5. 2.61	3,152	3.314*

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

No significant effect could be found for the highest qualification of the respondent and the use of SDMs. It has, however, had a significant effect on the tailoring of Agile SDMs, $F(3,152) = 3.314$, $p < .05$. A medium practical effect has been found between the group with a university/Technicon degree and the group with an honours degree ($d = 0.49$), as well as the group with a master's degree ($d = 0.57$).

No significant relationships could be found with correlation analysis. The qualification of the individual does not contribute to the variables used to measure the use of an SDM (Table 7-4).

All the variables included in the measuring of non-use have been disregarded as they violated the assumptions of homogeneity, and insufficient number of participants indicated having a certificate/diploma, honours or a master's degree as the highest degree, and not using an SDM.

Regarding the results of the correlation analysis in Table 7-5, only one statistically significant relationship could be found. A strong positive relationship exists towards the levels of uncertainty of the system with $r_s = .45$, $p < .05$. This indicates that the higher the qualification of the individual, the levels of uncertainty increases towards the system. It can therefore, be concluded that, for this study, the qualification of the individual does not contribute to the non-use of an SDM.

It is concluded that the qualifications of an individual only indicate the tailoring of agile SDMs, indicating a direct relationship with the selection and use of an SDM.

7.2.5 Influence of the individuals' personal experience

The variable in the questionnaire used to measure the personal experience the individual had in systems development were reported at section 4.3.4. More than 85% of all the individuals in this study had at least two years of experience in systems development. Because the first three groups (from no experience to less than two years of experience) have been represented insufficiently by too few individuals, these three groups were merged into one group. This was in order to conduct further testing on the personal experience of the individual. The final groups are *less than two years*, *more than two*

years and less than five years, more than five years and less than 10 years, and more than 10 years.

ANOVA analysis was conducted on this variable towards the following variables reported in Table 7-11:

Table 7-11: ANOVA results for the personal experience against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 4.97 4. 4.23 5. 4.14 6. 2.97	3,130	4.953**
Intensity of unfamiliar SDMs	1. 2.93 4. 2.16 5. 1.64 6. 1.54	3,130	2.765*
SDM control as PMP	1. 4.02 4. 3.97 5. 3.79 6. 3.88	3,128	.406
Decomposition of system development	1. 4.05 4. 4.10 5. 3.95 6. 3.85	3,128	.700
Tailoring of other known SDMs	1. 2.34 4. 1.60 5. 1.54 6. 1.75	3,162	3.644*'
Tailoring of well-known SDMs	1. 3.24 4. 2.66 5. 2.62 6. 2.54	3,162	2.226
Tailoring of Agile SDMs	1. 3.02 4. 2.68 5. 3.14 6. 2.79	3,162	1.184

* $p < .05$, ** $p < .01$, *** $p < .001$, ' violated assumptions of homogeneity

The number of years of personal experience contributed to the use of either more familiar SDMs ($F(3,130) = 4.953$, $p < .01$), or unfamiliar SDMs ($F(3,130) = 2.765$, $p < .05$). Both these contributions were found to be of statistical significance (as indicated by the p -

value). A large practical significance has been found ($d = 0.87$) between the group with less than two years of experience and the group of 10 or more years of experience. This indicates that the more experience the individual has the more intense he or she will use SDMs. A medium practical effect has been found between those with 2-5 years of experience ($d = 0.55$) and those with 5-10 years of experience ($d = 0.55$) against those with more than 10 years of experience. No practical effect could be found for the unfamiliar SDMs.

It is significant that the variable indicating the tailoring of other known SDMs indicated a statistically significant effect, but at the same time violated the assumption of homogeneity.

Table 7-4 indicate the relationships found for this variable towards the variables used to measure the use of an SDM. A negative relationship has been found towards the intense use of more familiar SDMs ($r_s = -.22, p < .05$), an indication that the more experience the individual possesses the less intensely he or she will use the more familiar SDMs. This is in line with the move towards the *ad hoc development* direction organisations move into, as stated by Avison and Fitzgerald (2003a:81). Further negative relationships have been found towards the tailoring of well known ($r_s = -.16, p < .05$) and other ($r_s = -.18, p < .05$) SDMs, except the agile SDMs. Although these relationships are very weak they are still statistical significant.

Table 7-5 indicates that no statistically significant relationships exist between the personal experience of the individual and the variables used to measure the non-use of an SDM. The variables used to measure the non-use of SDMs have all violated the assumptions of homogeneity as too few individuals represented those with 2-5 years, 5-10 years, and the group with more than 10 years, but not using an SDM.

This section indicated that the personal experience of an individual contributed to the use of an SDM, and will probably use more familiar SDMs less intensely, will at the same time only tailoring SDMs slightly.

7.3 SUMMARY

This chapter has been devoted to a discussion of the results on an individual level, identifying those characteristics that contribute to the selection of an SDM. The following conclusions have been drawn for each of the characteristics:

- the gender of the individual does contribute to the selection and use of an SDM, as it contributes to the perception of how the SDM will provide support as project management, and how decomposed the system will most likely be.
- The age of the individual contributes directly to the use of SDMs. As the age of the individual increases, they will use familiar SDMs less intensely, as they will tailor it more. As the age decreases, the intensity of use of SDMs also decreases.
- The job category does not influence either the use or non-use of an SDM.
- The qualifications of an individual only indicate the tailoring of agile SDMs, indicating a direct relationship with the selection and use of an SDM.
- The personal experience of an individual contributed to the use of an SDM, and will probably use more familiar SDMs less intensely, will at the same time only tailoring SDMs slightly.

CHAPTER 8

RESULTS RELATING TO THE THEORETICAL FOUNDATION

8.1 INTRODUCTION

In Chapter 2 (section 2.5) the theoretical foundation for this study has been stated and discussed. The *Diffusion of Innovation* theory, specifically the *Innovation-Decision Process* from Rogers (2003:170) has been used. This consisted of five stages, *knowledge; persuasion; decision; implementation* and *finally confirmation*. This research then focuses on the persuasion stage, whereby one of the characteristics of persuasion is the compatibility of the innovation, leading to the decision. The use and tailoring of SDMs contributes to the implementation, leading to the confirmation of the decision made.

8.2 THEORETICAL FOUNDATION

In this study, an SDM is classified as a contingent innovation (Huisman, 2000:53). Two specific questions (the strictness of using the SDM, as well as the future adoption of the SDM, section 4.5.6, Tables 4-38 and 4-39) have been asked related to the decision process, which will be discussed in the following sections. The following figure provides an extract from the conceptual model constructed in Chapter 3 (3.7.5.1, Figure 3-2) to illustrate where these two questions position themselves in the conceptual model.

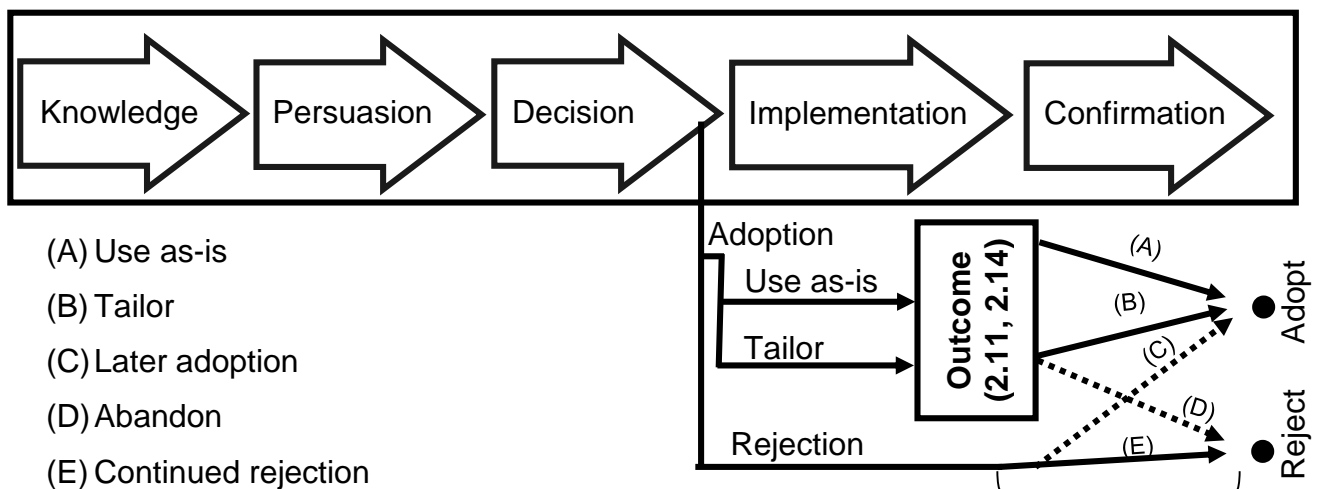


Figure 8-1: Extract from the conceptual model of the questionnaire 3.9

8.2.1 Strictness of the use of SDM

Figure 8-1 illustrates that during the implementation stage on organisation, project or individual could adopt, or reject the SDM. This variable relates to the adoption of the SDM (section 4.5.6, Table 4-38) and presented three predefined answers the respondents had to rate on a five-point Likert scale, whereby 1 represents *Not at all* and 5 *To a greater extent*. The third option, to use the SDM as a standard fits in the adoption section at the *use as-is* is indicated in Figure 8-1. Both the other options, to adapt the SDM on a project-by-project basis or to use it as a general guideline, fit into the adoption section at the *tailor* option.

This question has also been regarded as one of the variables that should be used to measure the use of an SDM. Throughout Chapter 5 to 7, it was be listed in the tables reporting the correlation results for the variables that are used to measure the use of an SDM.

ANOVA analysis was conducted on the first item (adopted on a project-by-project basis) towards the variables used to measure the use of an SDM.

Table 8-1: ANOVA results for using the SDM on a project-by-project strictness against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 2.18 2. 3.56 3. 4.86 4. 3.62 5. 4.23	4,129	3.803**
Intensity of unfamiliar SDMs	1. 1.26 2. 1.49 3. 2.79 4. 1.62 5. 2.15	4,129	2.514*
SDM control as project management	1. 3.76 2. 3.85 3. 3.69 4. 3.91 5. 4.06	4,127	.836

Decomposition of system development	1. 3.88 2. 3.94 3. 3.65 4. 3.89 5. 4.31	4,127	2.342
Tailoring of other known SDMs	1. 1.26 2. 1.47 3. 2.00 4. 1.81 5. 1.64	4,129	1.459
Tailoring of well-known SDMs	1. 1.86 2. 2.44 3. 3.10 4. 2.76 5. 2.73	4,129	2.721*
Tailoring of Agile SDMs	1. 2.64 2. 3.06 3. 3.06 4. 3.02 5. 2.76	4,129	.479

* $p < .05$, ** $p < .01$, *** $p < .001$

This analysis indicated that the strictness of use of an SDM adopted on a project-by-project basis towards the intensity of the more familiar SDM was statistically significant, with $F(4,129) = 3.803$, $p < .01$. Studying the responses between indicating *not at all*, and

- *to a little extent* indicated to have a large practical effect ($d = .89$)
- *neutral* indicated to have a large practical effect ($d = 1.28$)
- *to some extent* indicated to have a rather large (medium) practical effect ($d = .70$)
- *to a greater extent* indicated to have a large practical effect ($d = .82$)

The responses between *to a little extent* and *neutral* had a medium practical effect ($d = .62$), and between *neutral* and *to some extent* had a medium practical effect ($d = .59$).

A statistically significant difference has been found between adopting the SDM on a project-by-project basis and the intensity of unfamiliar SDMs, $F(4,129) = 2.514$, $p < .05$. The responses between the *not at all* and *neutral* options have a medium practical effect ($d = .67$). Responses between *to a little extent* and *neutral* had a medium practical effect

($d = .57$) as well as the responses between the *neutral* and *to some extent* options with $d = .51$.

Another statistically significant difference has been found between adopting the SDM on a project-by-project basis and the tailoring of well-known SDMs, $F(4,129) = 2.721$, $p < .05$. The responses between the *not at all* and

- *to a little extent* options have a medium practical effect ($d = .71$)
- *neutral* options have a very large practical effect ($d = 1.05$)
- *to some extent* options have a large practical effect ($d = .79$)
- *to a greater extent* options have a medium practical effect ($d = .66$)

Responses between *to a little extent* and *neutral* had a medium practical effect ($d = .56$). This concludes that the strictness of the adoption of SDMs on a project-by-project basis influences the use of SDMs, and the tailoring of well-known SDMs.

ANOVA analysis was conducted on the second item (used as a general guideline) and reported in Table 8-2.

Table 8-2: ANOVA results for using the SDM on a general guideline strictness against usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 2.42 2. 3.77 3. 3.33 4. 3.98 5. 4.04	4,129	1.321
Intensity of unfamiliar SDMs	1. 1.04 2. 1.49 3. 2.07 4. 1.82 5. 2.03	4,129	.733
SDM control as PMP	1. 3.73 2. 3.84 3. 3.75 4. 3.89 5. 4.03	4,127	.606

Decomposition of system development	1. 4.03 2. 3.50 3. 3.80 4. 3.89 5. 4.26	4,127	2.474*
Tailoring of other known SDMs	1. 1.08 2. 1.49 3. 1.67 4. 1.77 5. 1.78	4,129	.951
Tailoring of well-known SDMs	1. 1.50 2. 2.61 3. 2.48 4. 2.79 5. 2.85	4,129	2.709*
Tailoring of Agile SDMs	1. 2.00 2. 2.56 3. 2.80 4. 3.02 5. 3.15	4,129	1.716

* $p < .05$, ** $p < .01$, *** $p < .001$

This analysis indicated that the strictness of use of an SDM adopted on a guideline strictness towards the decomposition of the system ($F(4,127) = 2.474$, $p < .05$) and the tailoring of well-known SDMs ($F(4,127) = 2.709$, $p < .05$) has been significant, meaning that systems were more decomposed while the SDM was used as a general guideline, while tailoring well-known SDMs. As there have been insufficient frequencies on some of the items, further analysis has not been performed on this data.

Table 8-3 reports the results from the ANOVA performed on the third item for which the SDMs are used so strictly that they act as a standard to be followed rigorously.

Table 8-3: ANOVA results for using the SDM on a standard strictness against the usage of SDMs

Variable	Mean	df	F
Intensity of more familiar SDMs	1. 2.46 2. 3.35 3. 3.78 4. 4.42 5. 3.97	4,129	2.858

Intensity of unfamiliar SDMs	1. 1.02 2. 1.54 3. 2.11 4. 2.01 5. 2.08	4,129	1.541
SDM control as Project Management	1. 3.91 2. 3.67 3. 3.72 4. 3.95 5. 4.18	4,127	1.918
Decomposition of system development	1. 3.75 2. 3.51 3. 3.77 4. 4.14 5. 4.42	4,127	5.482***
Tailoring of other known SDMs	1. 1.08 2. 1.45 3. 1.89 4. 1.89 5. 1.73	4,129	2.607*
Tailoring of well-known SDMs	1. 2.09 2. 2.24 3. 2.70 4. 3.05 5. 2.74	4,129	2.968*
Tailoring of Agile SDMs	1. 2.29 2. 2.95 3. 2.92 4. 3.13 5. 3.02	4,129	1.361

* $p < .05$, ** $p < .01$, *** $p < .001$

This analysis indicated that the strictness of use of an SDM adopted on a standard strictness are very statistically significant towards the decomposition of the system ($F(4,127) = 5.482$, $p < .001$). The following practical significances has been identified

- between *not at all* and *to a greater extent* (large practical effect) with $d = .83$
- between *to a little extent* and *to a greater extent* (large practical effect) with $d = 1.05$
- between *to a little extent* and *to some extent* (large practical effect) with $d = .73$
- between *neutral* and *to a greater extent* (large practical effect) with $d = .76$

Statistical significance has been found between the standard strictness and the tailoring of other SDMs ($F(4,129) = 2.607, p < .05$). The following practical effects have been found:

- a medium practical significance between *not at all* and *to a little extent*, $d = .48$
- a large practical significance between *not at all* and *neutral*, $d = .77$
- a medium practical significance between *not at all* and *to some extent*, $d = .74$
- a medium practical significance between *not at all* and *to a greater extent*, $d = .54$

Another statistical significance has been found between the standard strictness and the tailoring of well-known SDMs ($F(4,129) = 2.607, p < .05$). The following practical effects have been found:

- a medium practical significance between *not at all* and *neutral*, $d = .57$
- a large practical significance between *not at all* and *to some extent*, $d = .77$
- a medium practical significance between *not at all* and *to a greater extent*, $d = .51$
- a medium practical significance between *to a little extent* and *to some extent*, $d = .65$

The results above indicate the statistical difference, which are of meaning between the adoption of the SDM on different levels of strictness (project-by-project, guideline and standard) between the variables used to measure the selection and use of an SDM.

Correlation analysis has been conducted on this variable towards the variables used to measure the use of an SDM. These results are presented in the following table.

Table 8-4: Correlations of strictness of SDM use and the use of an SDM

Variable	Project-by-project	General guideline	Standard
Type of SDM	-	-	-
Intensity of more familiar SDMs	.10	.04	.09
Intensity of unfamiliar SDMs	-.01	-.01	.10
Intensity of in-house SDMs	-.01	.07	.02
Intensity of Scrum	.07	.09	.18*
Control provided as PMP	.15	.11	.19*
Decomposition of system development	.21*	.24**	.36**
Time of use	-.02	.00	.00
Tailoring of other known SDMs	.00	.13	.16
Tailoring of well-known SDMs	.13	.20*	.22*
Tailoring of agile SDMs	.03	.17*	.14

* $p < .05$, ** $p < .01$, *** $p < .001$

From Table 8-4 it can be noted that the strictness has positive relationships with the decomposition of the system development, regardless of the level of strictness. Although these relationships are rather weak they are statistical significant. The strictness of using an SDM as a general guideline indicated positive relationships with the tailoring of well-known SDMs ($r_s = .20$, $p < .05$) as well as with the tailoring of agile SDMs ($r_s = .17$, $p < .05$). The use of the SDM as a standard was found to have relationships with the intense use of the Scrum SDM ($r_s = .18$, $p < .05$), but to tailoring the well-known SDM ($r_s = .22$, $p < .05$) rather than tailoring agile SDMs.

Respondents answering this question in the questionnaire indicated that they used an SDM, and therefore no analysis could be made towards those variables used to measure the non-use of an SDM.

This section concludes that the level of adoption of the SDM (project-by-project, guideline and standard) do influence the level the system is decomposed, as well as the tailoring of SDMs. Adopting the SDM on a project-by-project basis influences the intense use of SDMs.

8.2.2 Future adoption of the SDM

This section refers to the confirmation stage as indicated in Figure 8-1. The confirmation stage tries to confirm the decision made about the innovation (SDM) to determine if the SDM should (1) be used as-is; (2) be tailored before reuse; (3) be adopted later; (4) be abandoned; or (5) continue to be rejected.

The respondents reported a high mean (3.97 out of 5) for the appropriateness of the SDM they were using (section 4.5.6). Further, they indicated that they felt the SDM they were using was suited (negative statement with a mean of 2.27 out of 5), indicating they felt their SDM was appropriate and suited to use in future projects in which they were involved.

Some SDMs need to undergo major changes before they are used again, but also feel somewhat neutral about this and not ready to suggest it. This could be the reason they have already made some changes to the SDM in the past, and some changes need to be made before reuse. This aligns with the strong feeling the respondents indicated that some changes needed to be made before they could use the SDM in the future (mean of 3.28 out of 5).

Correlation analysis was conducted on this variable towards the variables used to measure the use of an SDM. These results are presented in the Table 8-5.

The results presented in the table below regarding the future use of the SDM and whether changes should be made before future use, found the following relationships:

- Regarding the statement that the SDM is appropriate and could be used just as-is in the future, positive relationships were found towards the SDM control as project management ($r_s = .22, p < .05$) and the decomposition of the system ($r_s = .22, p < .05$). This indicates that when the SDM was adopted in such a manner it provided support for the project management, and towards the decomposition of the system, it would be regarded as appropriate for the future as the SDM and may be adopted and tailored to the extent that it suites the organisation, the projects, and the individuals.

Table 8-5: Correlations of future use of SDM and the use of an SDM

Variable	Appropriate	Some changes	Major changes	Are not suited
Intensity of more familiar SDMs	-.04	.23**	.32**	.19*
Intensity of unfamiliar SDMs	.03	.09	.24**	.08
Intensity of in-house SDMs	.02	-.05	-.09	.00
Intensity of Scrum	.15	-.01	.06	.12
Control provided as project management	.22*	.10	.07	-.15
Decomposition of system development	.22*	.18*	.16	.02
Time of use	.10	.01	-.12	.19*
Tailoring of other known SDMs	-.07	.21*	.39*	.26**
Tailoring of well-known SDMs	-.03	.19*	.38*	.25**
Tailoring of Agile SDMs	.02	-.04	.11	.18**

* $p < .05$, ** $p < .01$, *** $p < .001$

- Regarding the statement that the SDM should undergo some changes, a positive relationship has been found towards the intensive use of more familiar SDMs ($r_s = .23$, $p < .01$), indicating that the more familiar SDMs are suited once some changes have been made. The well-known SDMs are also tailored ($r_s = .21$, $p < .05$), as well as the other SDMs ($r_s = .19$, $p < .05$). The other positive relationship is towards the decomposition of the system with $r_s = .18$, $p < .05$. This indicates that as the participant feels stronger that the SDM needs some changes, the more decomposed the system are. This indicates that participants felt the system should be one whole, and not very decomposed.
- For the statement that the SDM should undergo major changes before future use, statistically significant relationships have been found towards the intensive use of the more familiar SDMs ($r_s = .32$, $p < .01$) and the tailoring of the well-known SDMs ($r_s = .24$, $p < .01$). This is also true for the intensive use of unfamiliar SDMs ($r_s = .39$, $p < .01$) and the tailoring of the other SDMs ($r_s = .38$, $p < .01$).

- For the statement that the SDM are not suited for future use, weak positive relationships have been found towards the intensive use of more familiar SDMs ($r_s = .19, p < .05$) and the time the SDM has been used ($r_s = .19, p < .05$). Other relationships were present to the tailoring of the well-known SDMs ($r_s = .25, p < .01$), agile SDMs ($r_s = .18, p < .01$), and the other SDMs ($r_s = .26, p < .01$).

It is concluded that the tailoring of SDMs and the intense use thereof will influence future use. In some cases, the support the SDM provides as project management and the decomposition of the system will contribute to the appropriateness of the SDM for future use.

8.2.3 Project outcome

The outcome of the project was measured with whether the project was completed, implemented and still in use (section 4.4.4.6). It is noted (with crosstabs analysis) that 91% of the 81% of the projects that have used an SDM (section 4.4) are still implemented and being used. It could also be noted that 87.5% of the 19% of projects that did not use any SDM are also still implemented and in use. Furthermore, all projects that have been cancelled before time had used an SDM. All projects of the 19% that did not use an SDM were completed; only 3.1% not being implemented. The remaining 96.9% of the 19% of the project were implemented, but only 9.4% are no longer in use. From the 81% of projects using an SDM, 93.3% were implemented, but only 2.2% are no longer in use. Only 6.7% of the 81% of projects were not implemented (where 5.2% of the projects were completed). This indicates that the use of an SDM may have an influence on the outcome of a project, but further analysis was carried out to determine if this was true.

The order of the four options of this question (section 4.4.4.6) are from projects that have been terminated with the lowest order against the projects that has been completed, implemented, and used as the highest order. This order (as presented in the questionnaire) will be used for the further analysis reported below.

The table below will provide all the variables used in this chapter for measuring the use (Table 8-4) and the non-use (Table 8-7) of an SDM using correlation analysis.

Regarding the outcome of the project there has been a negative relationship with the strictness of adopting the SDM project-by-project, $r_s = -.23$, $p < .01$ indicating that as the projects were more successfully completed, the SDM was less strongly adopted on a project-by-project basis. This was also found with the SDM being a general guideline ($r_s = -.20$, $p < .05$) and the SDM being a standard ($r_s = -.18$, $p < .05$). Further relationships include the negative relationship between the project outcome and the decomposition of the system ($r_s = -.19$, $p < .05$), indicating that as the outcome of the system tends to be where the system is used it was not decomposed. Although this is a weak relationship, it is still statistically significant. The interaction with other external systems was also found to have an impact on the outcome of the project ($r_s = .23$, $p < .01$), which may indicate that some of the functions needed to be performed in a system already included in other systems, and this could be used to complete this system in a more favourable manner.

Table 8-6: Correlations of project characteristics and the use of an SDM

Variable	Project outcome	Months in use	Well-planned installation	Timely provision of information	PMP	High efficient process	Success of the system	Portability of the system	Documentation of the system
Intensity of more familiar SDMs	-.05	.11	-.46	-.08	.00	.05	-.03	.15	.18*
Intensity of unfamiliar SDMs	-.01	.18*	-.17	-.07	.09	.05	-.02	.05	.15
Intensity of in-house SDMs	.00	.24**	.43	.37	.05	.17*	.05	.02	.09
Intensity of Scrum	.04	-.09	-.09	.05	.19	.15	.14	.24**	.15
Control provided as PMP	-.07	-.01	.61	.67*	.25**	.19*	.18*	.08	.12
Decomposition of system development	-.19*	.14	.55	.40	.22*	.14	.30**	.22*	.25**
Time of use	.11	.07	.14	.09	.11	-.05	.15	.02	.16*
Tailoring of other known SDMs	-.13	.04	.27	.48	.08	.12	-.03	.12	.16*
Tailoring of well-known SDMs	-.18*	.08	.23	.17	.14	.14	.05	.16*	.20**
Tailoring of agile SDMs	-.07	.01	-.05	.32	-.01	.02	-.05	.15	-.01
Strictness of use: adapted on project-to-project basis	-.23**	-.15	.72*	.20	.10	.13	.21*	.28**	.04
Strictness of use: used as general guideline	-.20*	.04	.22	.23	.10	.06	.19*	.19*	.06

Strictness of use: a standard which is used rigorously	-.18*	.23*	.54	.26	.09	.01	.24**	.26**	.22**
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* $p < .05$, ** $p < .01$, *** $p < .001$

Cells with a grey shadow represent strong relationships between the variables.

Table 8-7: Correlations of project characteristics and the non-use of an SDM

Variable	Project outcome	Months in use	Well-planned installation	Timely provision of information	PMP	High efficient process	Success of the system	Portability of the system	Documentation of the system
Non-adoption of SDMs	-.07	-.13	-	-	-.06	.06	.02	.02	-.11
Reasons for non-use:	-	-	-	-	-	-	-	-	-
Environment not supporting	.14	-.12	.78	.40	.28	.43*	.24	.48**	.24
Lack of experience	-.09	.10	.78	.80	-.01	.05	-.08	.13	.00
Uncertainty	.24	-.12	.82	.95	-.02	.28	-.09	.22	-.03
Long term commitment	-.02	-.04	.33	-.26	-.10	.11	.08	.06	.08

* $p < .05$, ** $p < .01$, *** $p < .001$

Figure 4-4 in Chapter 4 illustrates the cumulative percentage of months the systems have been in use (representing the 90% of systems still in use). It could be noted that the minimum number of months was one, with the maximum of 500 reported. All the projects in which the system has been in used for only one month have been indicated to be of a small to medium size, with only one being large. The system in use for 500 months (41 years and 8 months at the time of the study) has been reported by a programmer/developer with more than 10 years of experience, with a certificate/diploma as its highest qualification, working in the transport and communication sector. The time the system has been used has a moderate relationship with the size of the project, $r_s = .35$, $p < .01$ indicating that the more time spent on the project with the development of the system the longer users are likely to use it. This number of months the system was in use is also statistically significant, with $r_s = .24$, $p < .01$, indicating that as the project uses an in-house SDM the system will be in use for a longer time.

Respondents, who have indicated that the project was completed, irrespective of the system has been implemented, said that they felt that the project had a well-planned implementation process (a very strong positive relationship confirmed this with $r_s = .72$, $p < .05$ being statistically significant), but also that each stage of the implementation had provided them with comprehensive control information (a very strong positive relationship confirmed this with $r_s = .67$, $p < .05$ being statistically significant). This indicated that a well-planned implementation plan, together with enough information when needed, does not depict the future success of the system.

No statistically significant relationship could be found with the variables measuring the non-use of an SDM towards the outcome of the project.

This indicates that the decision to use or not to use an SDM has an influence on the outcome of the project, but it is assumed that people are making a more conscious decision not to use an SDM, as all the projects (19%) not using an SDM were completed. Those projects that used an SDM, but were cancelled/terminated before time, could be motivated that an SDM was not necessary to use, as the use of the SDM made the project heavier.

8.2.4 The success of the project management process

Using factor analysis, this variable (section 4.4.4.8) has been divided into two components with the first being the *Project management Process* (PMP), and a *high efficient process*. Table 8-4 presents the correlation results obtained for these two components towards the variables used to measure the use of an SDM.

Only rather small relationships have been found in these correlation results. The PMP had positive relationships with the SDM control as project management ($r_s = .25, p < .01$), and towards the decomposition of the system, with $r_s = .22, p < .05$. The SDM control as a project management also indicated a relationship with the high efficient process, with $r_s = .19, p < .05$, and the intense use of in-house developed SDMs ($r_s = .17, p < .05$).

Table 8-7 presents the correlation results obtained for these two components towards the variables used to measure the non-use of an SDM. This only indicates one significant relationship between the high efficient process and the environment that is not supported ($r_s = .43, p < .05$), indicating that as the environment becomes increasingly unsupported, the efficiency of the process needs to grow.

Regression analysis was performed to determine a relationship between this variable, the variable for the success of the system (section 8.2.5) to predict the intensity of SDM usage. The following table illustrates the results for the regression towards the intensity of SDM usage.

Table 8-8: Regression results for support SDM provided as project management and the success of the system to predict the intensity of use of more familiar unfamiliar SDMs (N=134)

Dependent variable	Intensity of more familiar SDMs			Intensity of unfamiliar SDMs		
	B	SE B	β	B	SE B	β
PMP	-.133	.274	-.058	.274	.233	.139
High efficient process	.138	.187	.080	.138	.159	.092
Success of the system	.056	.280	.021	-.183	.238	-.078

R^2	.005	.032
f^2	.01	0.03
F	.201	1.448

The results of the regression analysis above do not appear to be of any significance, and therefore these variables are not sufficient to predict the intense use of SDMs. The R^2 value indicates that at most the regression could predict 0.5% or 3.2% of the total variance for the intensity of well-known and unfamiliar SDMs, respectively. Both models report a very small effect size (f^2), confirming that both models are not significant.

Table 8-9 reports the regression analysis for the dependent variables of the SDM control as project management and the decomposition of the system (section 4.4.4.8). The predictor variables are those of the PMP, the high efficient process (section 4.4.4.1) and the success of the system (section 4.4.4.10).

Table 8-9: Regression results for support SDM provided as project management and the success of the system to predict the SDM control as project management and the decomposition of the system (N=132)

Dependent variable	SDM control as Project management			Decomposition of the system		
	B	SE B	β	B	SE B	β
PMP	.115	.111	.120	-.135	.116	-.132
High efficient process	.054	.076	.074	.067	.080	.087
Success of the system	.149	.115	.132	.422	.120	.349***
R^2	.072			.105		
f^2	0.08			0.12		
F	3.287*			5.026**		

* $p < .05$, ** $p < .01$, *** $p < .001$

Both the regression models reported above are of statistical significance. The dependent variable of the SDM control as project management reports $F(3,128) =$

3.287, $p < .05$, while the decomposition reports $F(3,128) = 5.026$, $p < .01$. For this model, success of the system contributed to the decomposition of the system. Both these models report to explain at most 10.5% (compared to the 7.2%) for the decomposition of the system (to the SDM control as project management). Both models report a small effect size, indicating that these are not practically important.

Table 8-10 reports the regression analysis for the dependent variables of the tailoring of well-known, agile and other SDMs (section 4.5.4). The predictor variables are those of the PMP, the high efficient process (section 4.4.4.1) and the success of the system (section 4.4.4.10)

Table 8-10: Regression results for support SDM provided as project management and the success of the system to predict the tailoring of well-known, agile and other SDMs (N=166)

Dependent variable	Tailoring well-known SDMs			Tailoring other SDMs			Tailoring Agile SDMs		
	B	SE B	B	B	SE B	β	B	SE B	β
PMP	.049	.146	.037	.185	.163	.125	-.010	.177	-.007
High efficient process	.161	.098	.158	.086	.109	.075	.086	.119	.070
Success of the system	-.018	.144	-.012	.004	.161	.002	-.088	.175	-.049
R^2	.031			.033			.005		
f^2	0.03			0.03			0.01		
F	1.753			1.838			.251		

None of the three models in Table 8-10 were found to be of any statistical significance. It can further be noted that a very small portion of the variance will be explained by these models if the results were significant. The very small effect sizes also indicate that these models are of no practical significance.

It can be concluded that the PMP is dependent on the choice of SDMs with the use of in-house developed SDMs. This means that the developed SDM will address their needs specifically. The PMP is also dependent on the decomposition of the system, the high efficient process and the control the SDM provides as project management.

8.2.5 Success of the system/product

The variable of the success of the system/product has been divided into three components, representing the *success of the system*, the *portability of the system*, and the *documentation of the system* (section 4.4.4.10).

The mean for the component of the success of the system is 4.20 (out of 5, SE = 0.66) for the 81% of projects that have used an SDM. The mean drops to 3.91 (SE = 0.70) for the other 19% of projects that did not use an SDM. This high means indicates that the respondents agreed that the system was a success.

The portability of the system had a mean of 3.68 agreeing with the statement that the system had high portability. The mean fell slightly for the documentation of the system to 3.10, indicating that respondents were moving more to the agile methodologies, but still using the more familiar SDMs (section 4.4.1).

The correlations determined are reported in Table 8-4 regarding this variable. Multiple relationships have been found to be significant when investigating the relationship between the success of the system and the variables used to measure the use of an SDM. The following three paragraphs will each indicate the relationships found towards each of the three variables of this section.

The success of the system (the first component derived from the variable, section 4.4.4.10) indicated a weak positive relationship towards the SDM control as project management, with $r_s = .18$, $p < .05$ which are still statistically significant. A moderate relationship has been found with the decomposition of the system ($r_s = .30$, $p < .01$) indicating that as the system becomes more decomposed its level of success increases. Regarding the strictness with which the SDM is used, relationships have been found with all three types of strictness's, adapted on a project-by-project basis ($r_s = .21$, $p < .05$), used as a guideline ($r_s = .19$, $p < .05$), and as a rigorous standard ($r_s = .24$, $p < .01$). Using this it can be concluded that the more the SDM is used as a standard the more successful it will be (although it will also increase with the use on a project-by-project and guideline strictness).

The portability of the system (the second component derived from the variable, section 4.4.4.10) indicated a relationship of how intensely the Scrum SDM is used ($r_s = .24, p < .01$), also indicating that the system will be of a more decomposed manner ($r_s = .22, p < .05$). Using the Scrum SDM more intensely, it is confirmed that there exists a relationship to then tailor the agile SDMs more ($r_s = .16, p < .05$). Regarding the strictness with which the SDM is used, relationships have been found with all three types of strictness, adapted on a project-by-project basis ($r_s = .28, p < .01$), used as a guideline ($r_s = .19, p < .05$), and as a rigorous standard ($r_s = .26, p < .01$). It can be noted that both a standard SDM and one that is adapted on a project-by-project basis will contribute, but the adoption on a project-by-project is slightly better.

The documentation of the system (the second component derived from the variable, section 4.4.4.10) had a relationship with the more familiar SDMs ($r_s = .18, p < .05$), together with the strictness of an SDM as a standard rigorously used ($r_s = .22, p < .01$). This is true as the SDMs labelled as *more familiar* include the traditional ones whose documentation is a large component of the SDM, and these tend to be used more rigorously. As these are some of the first known SDMs, the relationship confirms a positive significant relationship to the tailoring of well-known SDMs ($r_s = .20, p < .01$). The documentation of the system has a rather weak positive relationship to the time the SDM is used ($r_s = .16, p < .05$), which could indicate that the documentation will provide future *lessons learned* to help in the application of the SDM. A statistical significant relationship is found between the documentation and the decomposition of the system with $r_s = .25, p < .01$.

Table 8-7 presents the correlation results obtained for these variables towards the variables used to measure the non-use of an SDM. The only statistically significant relationship found is that the portability of the system has a strong relationship towards the environment that is not supported with $r_s = .48, p < .01$.

This concluded that the success of the system developed was dependent on the use of an SDM, as there are insufficient results to indicate that the success, portability and/or documentation of the system contributed to the decision not to use an SDM.

8.3 SUMMARY

This chapter has been devoted to the discussion of the two questions at the end of the questionnaire, which had direct reference to the theoretical foundation, from Rogers (2003): The *Innovation-Decision Process* from within the theory of the *Diffusion of Innovations*. Conclusions have been drawn that characteristics influence the future use and adoption of the SDMs. The questions measuring the project outcome was also discussed and the following conclusions have been drawn:

- The decision to use or not to use an SDM has an influence on the outcome of the project, but it is assumed that people are making a more conscious decision not to use an SDM, as all the projects (19%) not using an SDM were completed. Those projects that used an SDM, but were cancelled/terminated before time, could be motivated that an SDM was not necessary to use, as the use of the SDM made the project heavier.
- The PMP is dependent on the choice of SDMs with the use of in-house developed SDMs. This means that the developed SDM will address their needs specifically. The PMP is also dependent on the decomposition of the system, the high efficient process and the control the SDM provides as project management.
- The success of the system developed was dependent on the use of an SDM, as there are insufficient results to indicate that the success, portability and/or documentation of the system contributed to the decision not to use an SDM.

CHAPTER 9

DISCUSSION AND CONCLUSIONS

9.1 INTRODUCTION

Chapters 4 to 8 discussed the results obtained through the questionnaire. These results presented the background information of the respondents, as well as addressing each research objective stated in Chapter 1 (section 1.3). This chapter will present the framework constructed from the results obtained in the previous chapters with a discussion of each characteristic found to have a direct or indirect influence.

9.2 REVIEW OF THE PURPOSE OF THE STUDY

The aim of this study has been to develop a theoretical framework for the selection of an SDM. The research goals stated in Chapter 1 (section 1.3) were:

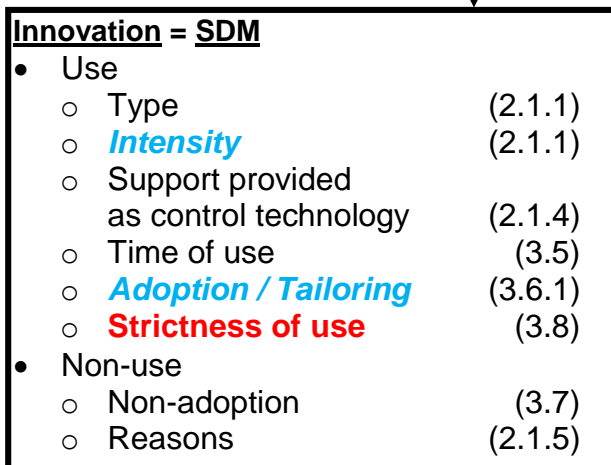
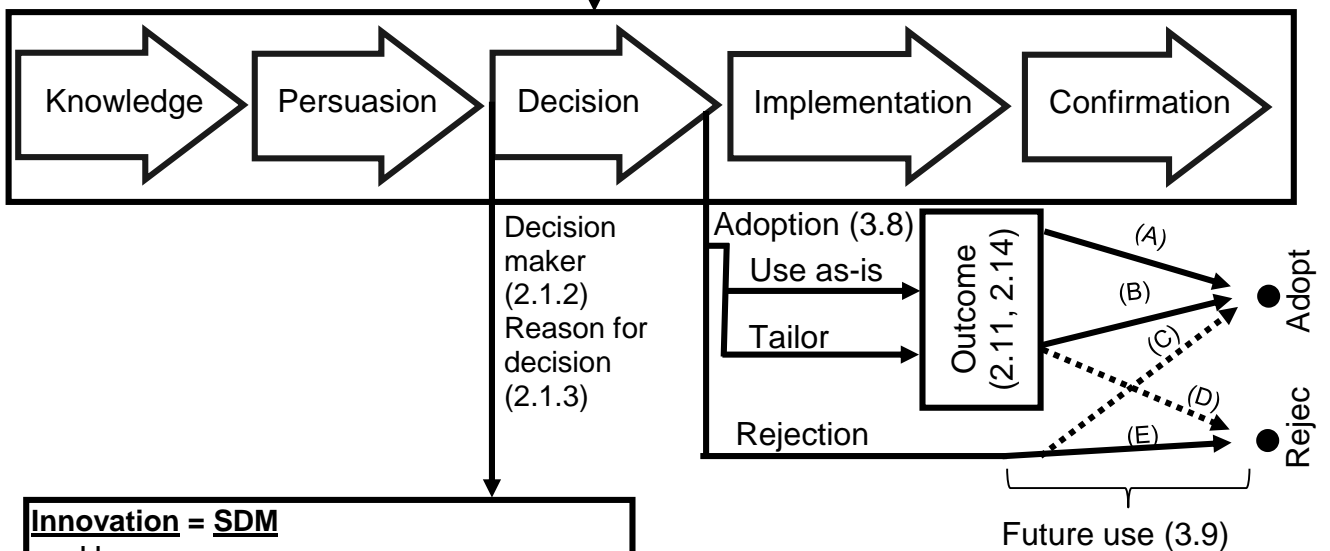
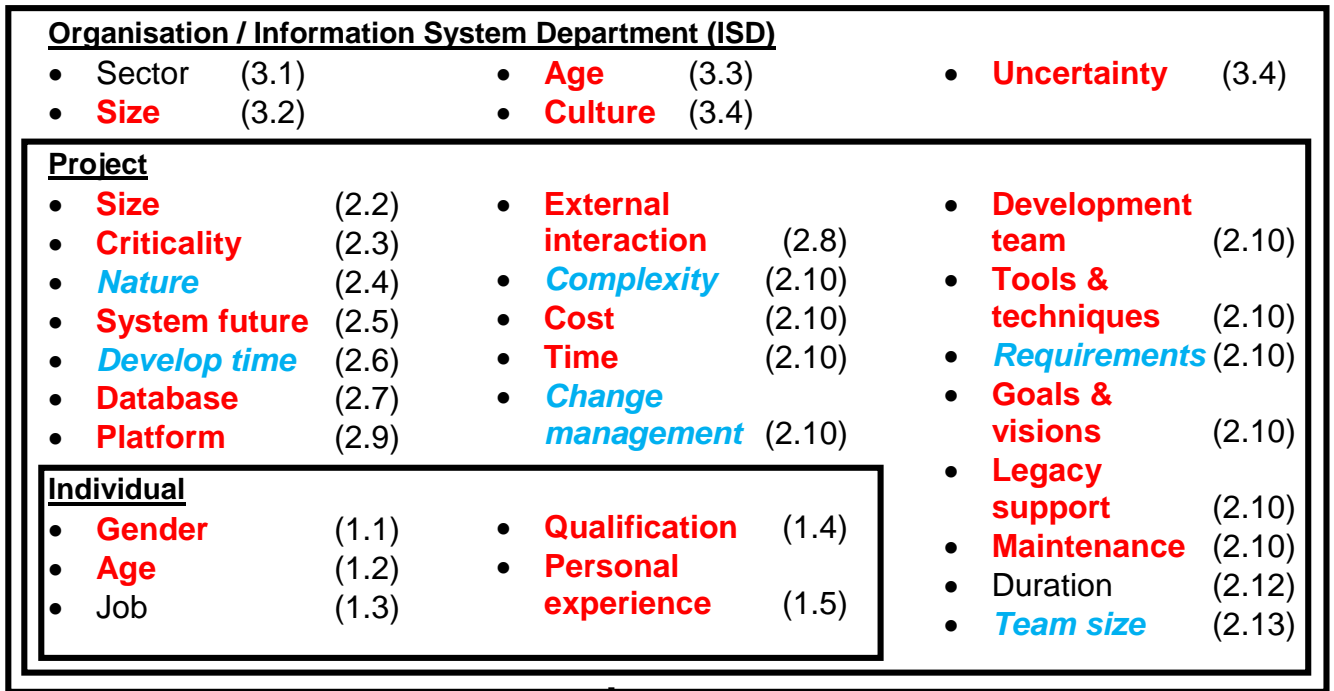
- i identify the characteristics influencing the selection of an SDM on an organisational level.
- ii identify the characteristics influencing the selection of an SDM on a project level.
- iii identify the characteristics influencing the selection of an SDM on an individual level.
- iv develop the theoretical framework, based on the evaluation.

These research objectives have been attended to in Chapter's 5 through to 8, and the final framework will be presented in the next section.

9.3 SUMMARY OF THE RESULTS

A conceptual model was constructed (section 3.7.5.1, Figure 3-2) for undertaking this research study, presented below.

Adoption Unit



- (A) Use as-is
- (B) Tailor
- (C) Later adoption
- (D) Abandon
- (E) Continued rejection

Legend: **Bold:** direct influence
Italic: indirect influence

Figure 9-1: Conceptual model indicating characteristics

The figure above indicates which characteristics were identified in this study as having an influence on the selection and use of an SDM. Those indicated in **bold** were found to have a direct influence on the choice of SDM, while the characteristics in *italics* were found to have an indirect influence on the choice of SDM, meaning they influenced other characteristics which may then influence the choice of SDM. The following sections discuss these characteristics as well as their influence.

9.3.1 Discussion of organisational characteristics

In Chapter 5, the culture and uncertainty of the organisation was found to have a direct influence on the selection of SDMs. The sector, size and age of the organisation had an influence on other characteristics that might have an influence on the selection of SDMs.

Each relationship of the characteristics that are indicated in **bold** or *italics* are illustrated in Figure 9-2 (below). A solid line indicates the relationship with one of the variables that are illustrated in Figure 9-1 to indicate the selection and use of an SDM (innovation). A dashed line illustrates an indirect relationship between two variables where both are not used to measure the selection and use or non-use of an SDM.

The following section will provide the relationships that exist between each of these characteristics.

- **Size**

As the size of the organisation increases,

- the age of the organisation increases;
- time the SDM will be/is used increases; and
- strictness of adoption becomes more project-by-project.

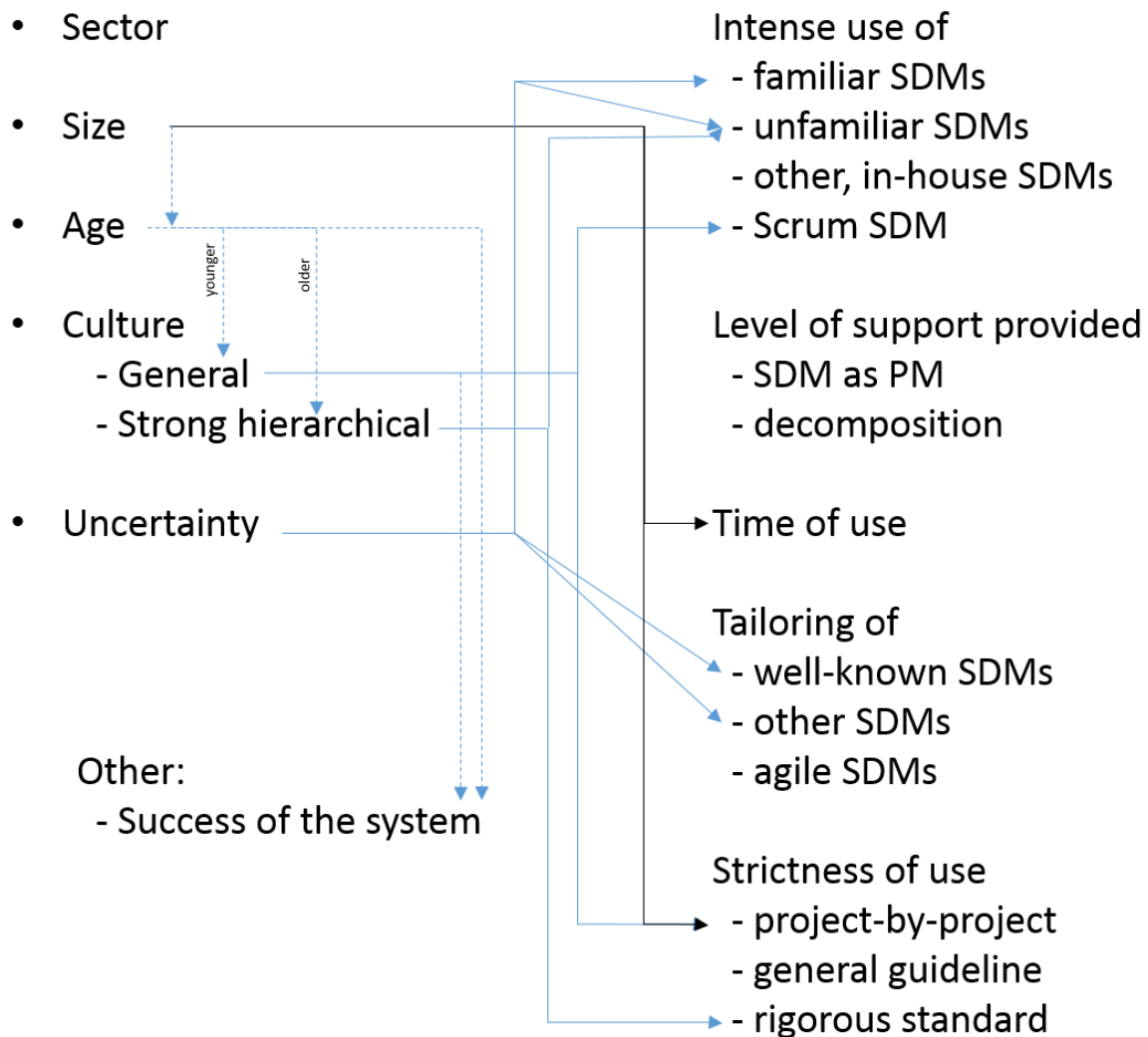
- **Age**

As the age of the organisation increases, the

- time of use of the SDM will increase;
- success of the system will increase;
- experience of the developers will increase; and

Organisation

Variables for selection and use



Non-adoption of SDMs

Reasons

- unsupportive environment
- lack of experience
- uncertainty
- long-term commitment

Figure 9-2: Relationships between characteristics of the organisation and the variables for the selection and use of an SDM

- culture becomes more of a hierarchical culture.

As the age of the organisation decreases, the

- culture becomes more of a general one.

- **Culture**

As the culture of the organisation becomes more of a general culture, the

- intense use of Scrum increases;
- success of the system increases; and
- adoption of an SDM will be done project-by-project, more than it will be used as a guideline or a standard.

As the culture of the organisation becomes more of a strong hierarchical culture, the

- intense use of unfamiliar SDMs increases; and
- SDM are adopted/used as a rigorous standard in the organisation.

- **Uncertainty**

As the uncertainty of the IS department increases, the

- intense use of familiar SDMs increases;
- intense use of unfamiliar SDMs increases;
- tailoring of well-known SDMs increases; and
- tailoring of other known SDMs increases.

The characteristics of the organisation have been constructed from various previous research published (Dyck & Majchrzak, 2012; Huisman, 2013; Nkone, 2013; Wagner, 2012). Most only indicated that the characteristics formed part of their selection model, with only a few indicating relationships. This provides an opportunity for this section to give some insight into what characteristics contributed to the SDM selected and being used, and how it contributes thereto.

Even though the sector did not contribute to the selection and use of an SDM in this study, no other relationships could be found in literature. Huisman (2000) investigated the organisation, but focused more on its maturity and culture (reported on below). No previous literature could be found regarding the age or size of an organisation towards the selection and use of an SDM. One conclusion of Huisman (2013:4) regarding the use

of an SDM for a longer time when the organisation had a certain culture predicted that the age might have an influence. From the relationships stated above, it can be seen that the age does not directly influence the selection or use of an SDM, but the age of the organisation influences the culture of the organisation, which then influences the selection and use of an SDM. This is in relation to the assumption that the age does indirectly influence the selection and use of an SDM.

Various research has been published regarding the influence of the culture of the organisation towards the selection, use, and adoption of SDMs. Vavpotic and Vasilecas (2011:108; 2012:142) found the culture of the team was one of the characteristics included in the ESS, but did not indicate what influence it had. Huisman (2000:161; 2013:4,12) wrote that the culture influenced the adoption of SDMs on an organisational level, which confirms the results of this study that the culture has a direct influence on the selection and use of the SDM. These results illustrate that the organisations with a more hierarchical culture will use those SDMs that may not be suited (section 5.2.4), it decreases the success of the system (section 4.4.4.10). Organisations with a more general culture will use more familiar SDMs, moving to the agile SDMs (section 4.5.2).

The uncertainty of the people in the organisation in the future was found to have a positive relationship to the adoption of SDMs on an individual level (Huisman, 2000:181). Van Dijk (2011:3) indicated that various factors could be grouped together as one theme, namely, uncertainty. This indicates that Van Dijk (2011:3) felt that uncertainty influences the selection and use of an SDM, but no relationships have been stated. This study found that uncertainty influences the selection, use and tailoring of SDM on an organisational level (section 4.5.2).

9.3.2 Discussion of project characteristics

In Chapter 6, the size and platform of the project had a direct influence on the selection of an SDM. The criticality, nature, future, development time, external interaction and team size had an indirect influence where these characteristics influence other characteristics that might have an influence on the selection of SDMs.

Each relationship of the characteristics indicated in **bold** or *italics* is illustrated in Figure 9-3 (below). A solid line indicates the relationship with one of the variables that is

illustrated in Figure 9-1 to indicate the selection and use of an SDM (innovation). A dashed line illustrates an indirect relationship between two variables where both are not used to measure the selection and use or non-use of an SDM.

The following section will provide the relationships that exist between each of these characteristics.

- **Project size**

As the size of the project increases, the

- intense use of Scrum increases;
- intense use of more familiar SDMs increases;
- tailoring of well-known SDMs increases;
- intense use of unfamiliar SDMs increases;
- tailoring of other SDMs increases;
- SDM is adopted/used as a guideline or a standard; and
- control the SDM provides as project management increases.

- **Project criticality**

As the criticality of the project increases, the

- size of the project increases;
- criticality of the system increases; and
- time the SDM will be used increases.

- **Project nature**

As the nature of the project moves from a new development to a complete redo of the system, the

- more timely information is needed;
- development time increases; and
- communication through technology decreases.

Project

Variables for selection and use

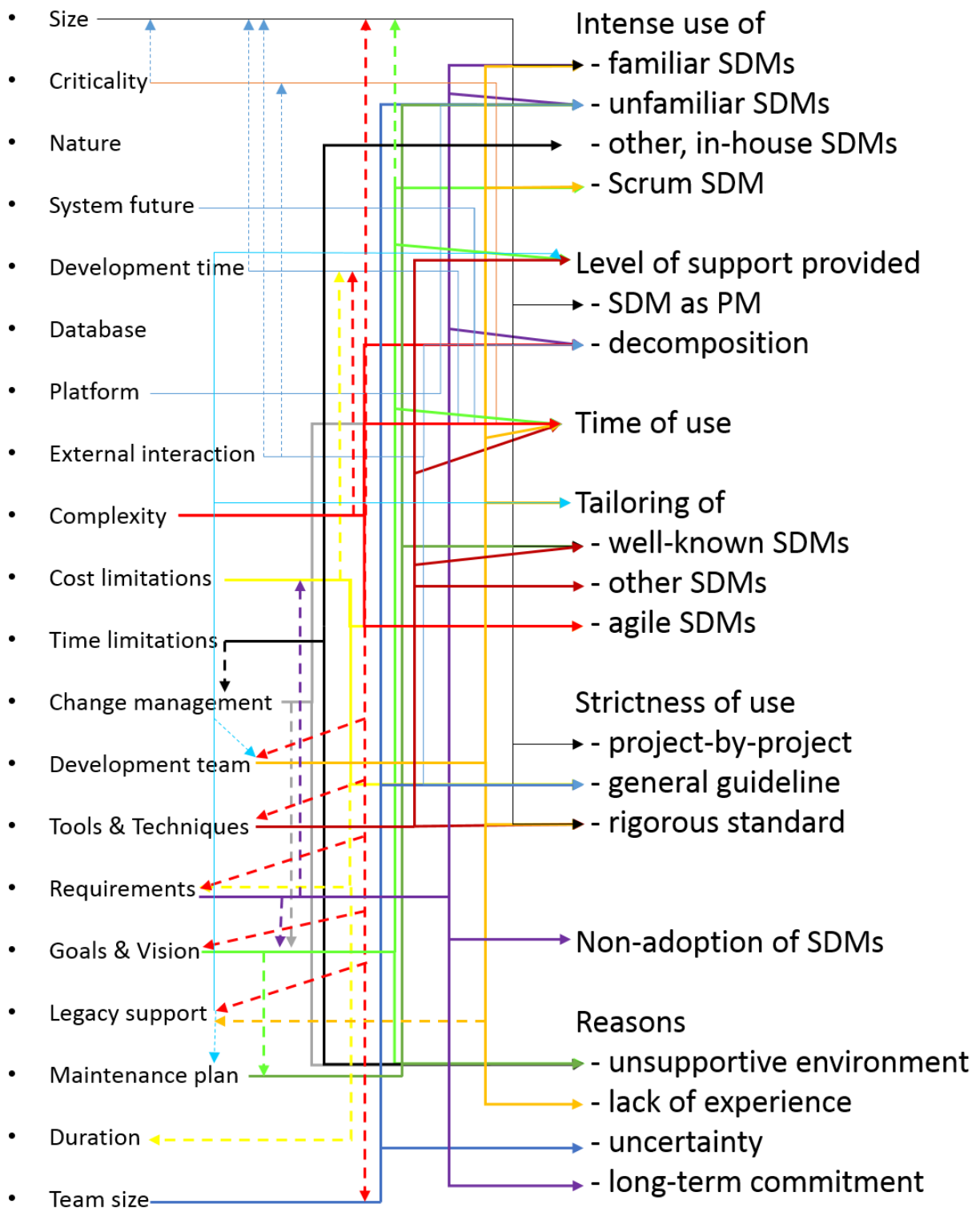


Figure 9-3: Relationships between characteristics of the project and the variables for the selection and use of an SDM

- **Systems' planned future**

As the planned future moves from maintenance to minor/major changes to new versions, the

- decomposition of the system decreases; and
- time the SDM will be used increases.

- **Development time**

As the development time increase, the

- time the SDM will be used increases;
- size of the project increases;
- complexity of the system increases; and
- efficient process decreases.

As the development time decreases, the

- high efficient process increases.

- **Project platform**

As the platform of the system go from a desktop to web based to mobile, the

- well-planned adoption plan decreases; and
- intense use of unfamiliar SDMs increases.

- **External interaction**

As the number of external systems interacting with the system developed, the

- decomposition of the system increases;
- adoption of the SDM as a guideline decreases;
- size of the project increases;
- criticality of the system and project increases; and
- complexity of the system increases.

- **Project complexity**

As the complexity of the project increases, the

- tailoring of agile SDMs increases;
- decomposition of the system increases;
- the time the SDM are used increases;
- the size of the project increases;
- use of appropriate techniques increases;
- use of understandable requirements increases;
- training increase when a lack of knowledge increases;
- high levels of expertise increases;
- team size increases; and
- development time increases.

- **Project cost limitations**

As the limitations of the cost increases, the

- tailoring of agile SDMs increases;
- use of the SDM as a guideline decreases;
- development time increases;
- changing of requirements increase;
- duration increases; and
- uncertainty in the organisation increases.

- **Project time limitations**

As the limitations of time increase, the

- intense use of in-house developed SDMs increases;
- environment becomes unsupportive (when not using an SDM);
- effective change management increases;
- effective management of unexpected changes increases; and
- goals and vision increase.

- **Project change management**

As the change management increases, the

- time of use of the SDM increases;
- the environment becomes unsupportive (when not using an SDM);
- goals and vision increase;
- well-planned installation plan increases; and
- timely provision of information increases.

- **Project development team**

As the size of the development team increase, the

- intense use of familiar SDMs decreases;
- intense use of Scrum increases;
- decomposition of the system increases;
- the time the SDM are used increases;
- tailoring of SDMs increases (all types of SDMs);
- adoption of an SDM as a standard increase;
- lack of experience decreases;
- use of tools and techniques increases;
- legacy support increases; and
- timely provision of information increases.

- **Project tools and techniques**

As the project increases the use of tools and techniques, the

- tailoring of well-known SDMs increases;
- tailoring of other SDMs increases;
- control provided by the SDM as project management increases;
- decomposition of the system increases;
- time of use of the SDM increases;
- adoption of the SDM as a standard increase; and
- the complexity of the project and system increases.

- **Project requirements**

As the requirements of the project becomes more clear, the

- intense use of familiar SDMs increases;

- intense use of unfamiliar SDMs increases;
- decomposition of the system increases;
- cost limitations increase;
- goals and vision increase.

As the requirements change frequently, the

- non-adoption of an SDM increase;
- long-term commitment increases; and
- goals and vision decrease.

- **Project goals and vision**

As the goals and vision of the project becomes clear, the

- intense use of Scrum increases;
- control provided by the SDM as project management increases;
- decomposition of the system increases;
- the time the SDMs is used increases;
- complexity of the system is recognised;
- well-defined maintenance plan increases; and
- environment becomes unsupportive of the use of an SDM.

- **Project legacy support**

As the legacy support increases, the

- control provided by the SDM as project management increases;
- decomposition of the system increases;
- time of use of the SDM increases;
- development team becomes more cooperative;
- levels of expertise increase; and
- well-defined maintenance plan increases.

- **Project maintenance**

As the well-defined maintenance plan increases, the

- intense use of unfamiliar SDMs increases;
- time of use increases;

- tailoring of well-known SDMs increases; and
- environment becomes unsupportive of the use of SDMs.

- **Team size**

As the size of the team increases, the

- adoption of the SDM as a guideline decreases;
- time the SDM will be used increases;
- intense use of unfamiliar SDMs increases; and
- uncertainty about the system decreases.

The analysis of the existing selection models in Chapter 2 (section 2.3.5) indicated that almost all the selection models (including guidelines, frameworks, ES, tools and decision models) recognize the project. Although all recognize the project, not all indicates the influence of characteristics on the models, because, for example, a rule-based model has been developed, and only a few rules are published for illustration purposes. This limited the identification of characteristics, but those found have been used in this study (Burns & Dennis, 1985; Clara, 2013; Cockburn, 2000; Dyck & Majchrzak, 2012; Klopper *et al.*, 2007; Lemétayer, 2010; Mandal & Pal, 2013; Mnkandla & Dwolatzky, 2007; Nkone, 2013; Sheffield *et al.*, 2011; Vavpotic & Krisper, 2004; Vavpotic & Vasilecas, 2012; Vavpotic *et al.*, 2004).

This study has found that the size of the project directs the selection and use of SDMs (section 6.2.1). This is confirmed which the inclusion of the project size as characteristics in Vavpotic and Vasilecas (2012:141) and Mnkandla and Dwolatzky (2007:2). The criticality of the project has also been mentioned by previous researchers (Cockburn, 2000:65; Van Dijk, 2011:3; Vavpotic & Vasilecas, 2012:141), where this study identified the relationship with the time of use of an SDM (section 6.2.2), and the influence of the size of the project (section 6.2.1). Although Vavpotic & Vasilecas (2012:141) indicated that the nature of the development undertaken in the project is one of the characteristics, this could not be found to be true in this study (section 6.2.3).

The future of the system was identified as having an influence on the time of use (section 6.2.4) and the decomposition of the system (section 4.4.4.1), indicating that the more

decomposed the system the more the future will only be maintenance. This is in line with Vavpotic & Vasilecas (2012:141), where the same measures have been used in this study, as indicated in the list of characteristics. Cockburn (2000:65) and Mnkandla and Dwolatzky (2007:2) indicated the development time to be one of the characteristics, whereas this study only found an indirect relationship with the time of use (section 6.2.5).

Although Vavpotic and Vasilecas (2011:108; 2012:142) indicated that the type of DBMS used also had a certain kind of influence, this was not found to be true in this study (section 6.2.8), in which types of database did not indicate any relationship with the selection and use of an SDM. Both the platform and external interaction of systems were indicated as characteristics by Vavpotic and Vasilecas (2012:142), in line with the findings of this study. The platform indicated a relationship with the use of unfamiliar SDMs (section 6.2.7), which could be explained that the new platforms introduced, will lead to the development of new SDMs, categorised as unfamiliar SDMs due to the recent development thereof. The external interaction also contributed to the decomposition of the system (section 6.2.6) and the use of the SDM as a guideline (section 4.5.6).

The complexity of a project was found to have an indirect relationship towards the selection and use of an SDM, which may be in contrast with previous research (Al Ahmar, 2010:144, Mnkandle & Dwolatzky, 2007:2, Vavpotic & Vasilecas, 2011:108; Van Dijk, 2011:3), but these only list the characteristic but do not explain the relationship. The cost and time characteristics had also been found to have a direct influence, although it was only mentioned as characteristics without the relationships (Al Ahmar, 2010:144, Mnkandle & Dwolatzky, 2007:2, Vavpotic & Vasilecas, 2012:141-142). No literature could be found to indicate whether change management and tools & techniques had any relationship. This was confirmed when an indirect influence was found for the change management characteristic (section 6.2.12), and a direct influence for the tools & techniques (section 6.2.14).

Dyck and Majchrzak (2012), regarded the maintenance plan as one of the characteristics of the project, and it was found in this study that this was true as the maintenance plan had a direct relationship with the selection and use of SDMs (section 6.2.18). The size of the team was found to be an indirect characteristic of the selection and use of an SDM (Cockburn, 2000:65; Vavpotic & Vasilecas, 2012:143). As they did not indicate the relationships, the results of this study could not be compared to the literature.

9.3.3 Discussion of individual characteristics

Chapter 7 found the age and personal experience of the individual had a direct influence on the selection of SDMs. The gender and qualifications had an influence on other characteristics that might have an influence on the selection of SDMs.

Each relationship of the characteristics that is indicated in **bold** or *italics* is illustrated in Figure 9-4 (below). A solid line indicates the relationship with one of the variables that is illustrated in Figure 9-1 to indicate the selection and use of an SDM (innovation). A dashed line illustrates an indirect relationship between two variables where both are not used to measure the selection and use or non-use of an SDM.

The following section will provide the relationships that exist between each of these characteristics.

- **Gender**

If the gender is female, the

- SDM will be perceived as providing more control as project management; and
- system will be more decomposed.

- **Age**

As the age of the individual increases, the

- intense use of more familiar SDMs will decrease;
- intense use of unfamiliar SDMs will decrease;
- intense use of Scrum will decrease; and
- tailoring of well-known SDMs will increase.

- **Highest qualification**

As the highest qualification is ranked higher in the list presented in section 4.3.3, the

- tailoring of agile SDMs increase.

- **Personal experience**

As the number of years of personal experience increases, the

- intense use of more familiar SDMs decreases;
- tailoring of well-known SDMs decreases; and
- tailoring of other SDMs decreases.

Individual

Variables for selection and use

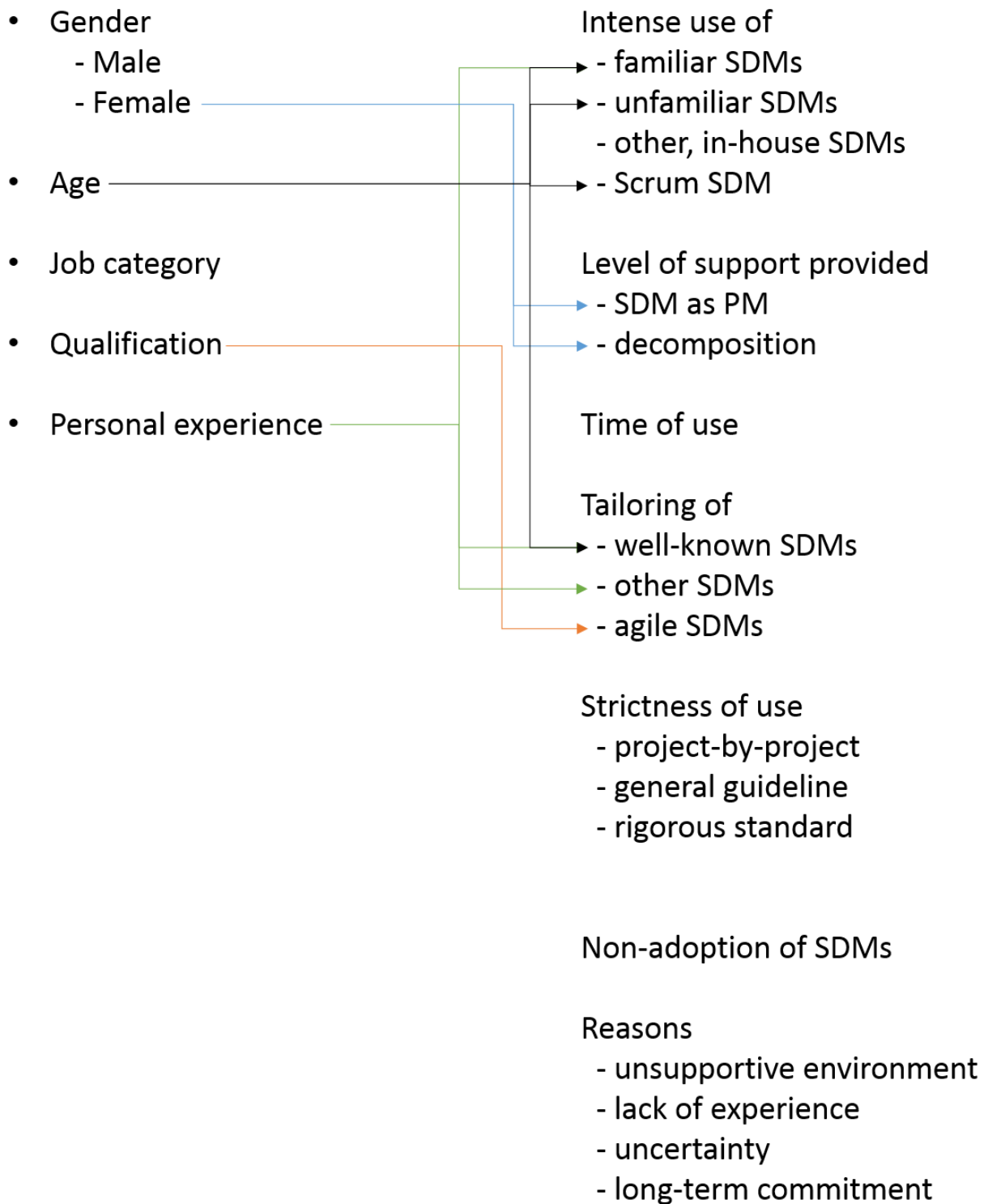


Figure 9-4: Relationships between characteristics of the individual and the variables for the selection and use of an SDM

Background information is usually included in questionnaires and used in analysis, but the question arises as to which of these characteristics had an influence on the selection and use of SDMs. The gender was found to have an indirect relationship with the selection and use of an SDM, as the female participants indicated higher levels of perceived control provided by the SDM (section 7.2.1). This could not be verified in the literature.

The influence of the age of the individual could not be verified in the literature studied for this research study. It has however been found that the age has a direct influence on the selection and use of an SDM (section 7.2.2). It could shortly be discussed that the younger the individual the more intensely they use and tailor an SDM, where those individuals who are older will not use SDMs so intensely, or even to tailor SDM more. Huisman (2002:134) stated that when an IS manager made the choice to use (and select) the SDM, this would not indicate whether the SDM would indeed be used. This is confirmed, as this study could not find any relationships with the selection and use of an SDM according to the job category of the individual.

A contrast has been found with the influence of the personal experience of the individual towards the selection and use of an SDM. This study found an indirect influence (section 7.2.4), while Huisman (2000:181) and Huisman and livari (2002:146) found no relationship between the qualification (education) and the selection and use of an SDM. This study found a more intense use of agile SDMs, the higher qualification the individual possessed.

Huisman (2000:181) found that the personal experience of an individual had a negative relationship to the selection and use of an SDM, but a positive relationship between the individual experience and the selection and use of an SDM (Huisman & livari, 2002:146). This study confirms the second relationship stated, whereby a direct influence was found towards the selection and use of an SDM according to the personal experience of the individual (section 7.2.5). The personal experience of the individual has also been stated as one of the characteristics by Vavpotic and Vasilecas (2012:142), but no relationships have been indicated.

9.3.4 Discussion of theoretical foundation

Each relationship of the characteristics that is indicated in **bold** or *italics* is illustrated in Figure 9-5 (below). A solid line indicates the relationship with one of the variables that is illustrated in Figure 9-1 to indicate the selection and use of an SDM (innovation). A dashed line illustrates an indirect relationship between two variables where both are not used to measure the selection and use or non-use of an SDM.

Chapter 8 discussed the questions related to the theoretical foundation used in this study. The following relationships have been identified:

- **Project outcome**

As the outcome of the project moved to the implementation of the system, the

- adoption of an SDM decreases for the project-by-project, general guideline and standard strictness;
- system is less decomposed; and
- number of interactions with external systems increase.

- **Project management process**

As the project management process increases, the

- control provided by the SDM as project management increases;
- system is more decomposed;
- high efficient process increases; and
- intense use of in-house developed SDMs increases.

- **Unsupportive environment**

As the environment becomes more unsupportive, the

- more efficient the process becomes.

Outcome

Variables for selection and use

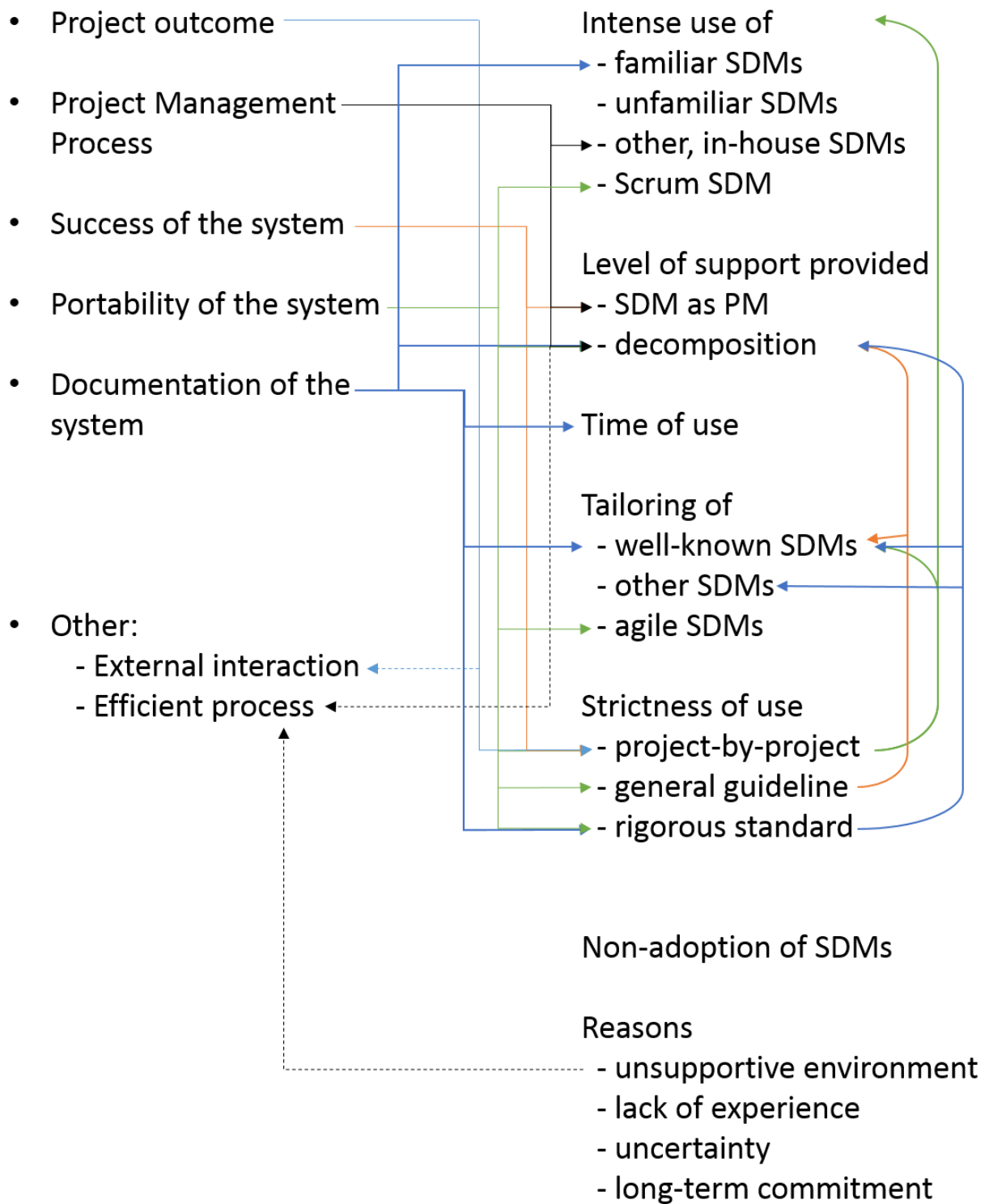


Figure 9-5: Relationships between characteristics of the outcome of the project and system and the variables for the selection and use of an SDM

- **Success of the system**

As the success of the system increases, the

- control provided by the SDM as project management increases;
- system is more decomposed; and
- adoption of an SDM tend to be more of a general guideline.

- **Portability of the system**

As the portability of the system increases, the

- intense use of Scrum increases;
- system is more decomposed;
- tailoring of agile SDMs increases; and
- strictness of adoption is project-by-project, as a standard, and then as a guideline.

- **Documentation of the system**

As the documentation of the system increases, the

- intense use of familiar SDMs increases;
- tailoring of well-known SDMs increases;
- time the SDM is used increases;
- system is more decomposed; and
- strictness of adoption is more of a standard.

- **Strictness of adoption: project-by-project**

As the strictness of the adoption of an SDM becomes more project-by-project, the

- use of SDMs increases;
- tailoring of well-known SDMs increases; and
- decomposition of the system increases.

- **Strictness of adoption: general guideline**

As the strictness of the adoption of an SDM becomes more of a general guideline, the

- decomposition of the system increases; and
- tailoring of well-known SDMs increases.

- **Strictness of adoption: standard**

As the strictness of the adoption of an SDM becomes more of a rigorous standard, the

- decomposition of the system increases;
- tailoring of well-known SDMs increases; and
- tailoring of other SDMs increases.

Wagener (2012:162) and Huisman (2000:216) provided a question that was used to determine if the SDM has been adopted on a project-by-project, guideline or standard basis. The selection and use leads to a decision made (the third stage in the Innovation-Decision Process from Rodgers (2003:170)) which will include the decision how strict to adopt the SDM. The sections above indicate what relationships exist between the other characteristics and the strictness of adopting an SDM. The confirmation stage formulated the last question in the questionnaire as to how suited the current SDM is for future use. Respondents felt that the SDMs they use are suited and appropriate for future use, and that only some of the SDMs need some changes before they could be used in the future (section 8.2.2).

Figure 9-5 illustrates that there exist relationships among the variables to predict the selection and use of an SDM. The strictness the SDM are adopted has an influence on the tailoring, and in some cases the intensity of use of SDMs (section 8.2.1). The strictness was also found to have an influence on the decomposition of the system (section 8.2.1).

These sections stated the relationships between the different characteristics of the organisation, the project and the individual. It was ascertained whether these characteristics had a direct or indirect influence on the selection and use of an SDM.

9.4 LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Although this study has reached its main aim of developing a theoretical framework for the selection of an SDM based on characteristics of the organisation, project and individual, the study still had some limitations:

- The people in the industry were not very keen on completing surveys that would not provide them with practical help with their work. This resulted in the low response rate for this study.
- The participants were all from a South African context, having joined social media networks on the Internet. This resulted in a convenient sample used, which further reduced the response rate for the survey.
- Using electronic-based surveys that were anonymous, no follow-up messages could be sent to remind them to complete the survey. Participants became resistant when they received more than one message to participate. Others sent comments stating how important they regarded this study, and therefore completed the survey as soon as they received it.

Future research possibilities became clear as this study progressed:

- This research could be refined for the framework to indicate specific SDMs to use, and not just a family or to indicate whether an SDM should be used or not.
- After the framework is refined it should be tested in the industry, which could result in multiple case studies for its adoption.
- Once the framework has been refined, tested and adjusted, it could be automated. This would result in more people using the framework as they do not need to follow the relationships, but could only input the values for the characteristic, and the automated framework could issue the use of an SDM for that specific project.
- Further research could be conducted to identify more characteristics that indicate and influence the use of SDMs on all three levels. There exist only a few selection models focusing on the organisation or the individual, as almost all focus on the project.

One of the comments received through an e-mail suggested future research which would help people to continue projects that have been put into the archive for some reason in the past:

“If you have any SDM suggestion for taking [...] old projects and taking them over from other people [...] as we have a lot of old projects that were put on hold [...] and now needs to start again and I have been finding it rather difficult to take these projects [...] and understanding their purpose as well as their current status as there were no documentation done in the past.” (E002)

9.5 PRACTICAL IMPLICATIONS OF THIS STUDY

This study has a number of implications:

- It has contributed to the contingency approach followed and mentioned in the literature. Various selection models have been developed, but most of these only considered the project.
- It has been identified that three levels should be included in the decision of an SDM, namely the organisation, project and individual. Characteristics of all three these levels will direct the selection and use of any SDM.
- Characteristics of the three levels have been identified, and relationships found between these and how they influence the selection and use of SDMs. Most of the previous models were constructed on rules, or some characteristics, but no relationships have been stated for these characteristics. Nor has it been shown whether they addressed the selection of the use of the SDM, or influenced some other characteristics that would guide or influence the selection and use of an SDM.
- As far as it could be determined, this is the first study regarding the contingency approach in South Africa, as well as the identification of relationships between three levels of influence.

This study will shape various types of future research into the selection of SDM, as well as characteristics that influence the selection process.

9.6 CONCLUSION OF THIS STUDY

The study aimed at constructing a theoretical framework from identifying characteristics for all the levels of adoption, which is the organisation, project and the individual. As all three levels are involved, the chosen SDM should be adopted by all three of these levels, as the characteristics of all three will guide the selection and use of an SDM. A literature study revealed that most of the models that already exist only focus on the project level, with only a few focussing on the organisation, and only one include the individual. No model includes all three levels.

The data gathered by a questionnaire with convenient sampling was statistically analysed to obtain any relationships in the data. Characteristics were identified to directly and indirectly influence the selection and use of an SDM on the different levels under investigation. The organisational level produced two characteristics with a direct relationship, and two characteristics with an indirect relationship. The project level produced eight direct characteristics, with ten indirect characteristics, while the individual level produced two direct and two indirect characteristics. These findings could be further refined through future research, also refining the framework to predict a specific SDM to be used for a specific project in a specific organisation with specific individuals working on the project.

This research is the start of multiple studies regarding the contingent use of SDMs, and the selection that should be made for SDMs on different levels.

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Annexure A

Cover letter



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April 2015

Best IT Professional

RESEARCH ON THE USE AND SELECTION OF SYSTEMS DEVELOPMENT METHODOLOGIES

The use of System Development Methodologies (SDMs) proliferated in recent years, where organizations tailor and publish SDMs they use. The number of SDMs today is unknown as there are so many on the market. Organizations have a difficult choice deciding which of these SDMs to choose for their project.

Contingency is the new approach organizations follow when developing an Information System. Contingency is when an organization adopt/tailor a methodology to best "fit" the project for which the methodology is used. After all this, some researchers attempted to develop a selection technique for selecting the most suitable "family of SDMs" for the given project. From this, it is critical that the decision results in the correct SDM to use, which will ultimately result in improved systems development.

Almost all of the existing techniques only choose a family of SDMs based on some characteristics of the project, but the characteristics of the organization (or Information System Department) and the individuals on the project also contribute to the selection. These three units need to accept the SDM before the implementation, and this research will contribute to include all three units, and not just the project unit.

In order to gain a better understanding of the use of ISDMs in practice, we need information from persons active in the field. Without your help it would be impossible to conduct this research. Would you please help us and complete the following questionnaire? It would take approximately 25 minutes of your time. All the information will be treated confidentially, and if you are interested, we will send you a copy of our findings. We really need your help!

I would appreciate it if the questionnaire could be completed as soon as possible.

Return deadline: 31 May 2015

Yours sincerely

A handwritten signature in black ink, appearing to read 'Jaco Viljoen'.

Mr. Jaco Viljoen
Masters Student

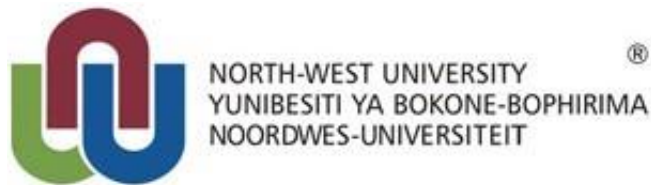
E-mail: 22149899@nwu.ac.za

Annexure B

Questionnaire

The selection and use of System Development Methodologies

* Required



The purpose of this study is the use and selection of ISDMs in the industry. Most existing selection techniques focus on the project alone, but the organization and individual will also have a great contribution to the selection of the ISDM to use.

Your participation in this study is highly appreciated and is completely voluntary and anonymous. The answers provided will be kept completely confidential.

Section A

Individual

1. 1.1 Gender *

Please indicate your gender:
Mark only one oval.

- Male
- Female

2. 1.2 Age *

Please indicate your age:
Mark only one oval.

- 18 or less
- 19 – 25
- 26 – 35
- 36 – 45
- 46 or older

3. **1.3 Job categories ***

Please indicate your job category:
Mark only one oval.

- Information system manager
- Project manager / leader
- Developer / Programmer
- Analyst
- Other: _____

4. **1.4 Qualifications ***

Please indicate your highest qualification obtained:
Mark only one oval.

- Senior certificate (high school)
- Certificate / Diploma
- University / Technicon degree
- Honours degree
- Master's degree
- Doctoral degree
- Other: _____

5. **1.5 Personal experience in systems development ***

Please indicate the time you have personal experience in systems development:
Mark only one oval.

- None
- Less than 1 year
- 1 year or more – less than 2 years
- 2 years or more – less than 5 years
- 5 years or more – less than 10 years
- 10 or more years.

Section B (Part 1)

Project

6. 2.1 SDM usage in projects *

Please indicate if an SDM was used in the last system development project:

Mark only one oval.

Yes Skip to question 7.

No Skip to question 12.

Section B (Part 2.1)

Project

Intensity of SDM used

Please indicate on a scale of 1 to 10, to what intensity was the following SDM used:

7. Mark only one oval per row.

	1	2	3	4	5	6	7	8	9	10
System Development Life Cycle (SDLC)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Structured Analysis, Design and Implementation of Information Systems (STRADIS)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rapid application development (RAD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unified Modeling Language (UML)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Web site design method (WSDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Structured Systems Analysis and Design Method (SSADM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Object oriented hypermedia design method (OO-HDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hypermedia design method (HDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soft Systems Methodology (SSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Object Modeling Technique by Rumbaugh (OMT)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Yourdon Systems Method (YSM)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LBMS system development method	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Jackson Systems Development (JSD)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Merise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information Engineering (IE)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Extreme Programming (XP)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scrum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8. If chosen "Other", please specify:

9. SDM Choice *

Who made the choice regarding what SDM to choose?
Check all that apply.

- Information system manager
- Project manager
- Developers
- Analyst
- Other: _____

10. Choice of SDM *

Why was the above SDM(s) chosen?

Section B (Part 2.2)

Project

11. Use of SDMs *

To what extent do you agree with the following statements? (1 is "Totally disagree" and 5 is "Totally agree")

Mark only one oval per row.

	1	2	3	4	5
The system development methodology helps to decompose the system to be developed in workable parts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps to estimate the size of the system to be developed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps to estimate the time and effort required for the development of a planned system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps to plan systems development projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps in defining useful milestones for the systems development projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps to organize system development projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system development methodology helps to keep the systems development projects under control.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The systems development methodology helps to estimate the project risks.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, the system development methodology helps us to manage our systems development projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip to question 13.

Section B (Part 2.1)

Project

12. Non-use of SDMs *

To what extent do you agree with the following statements?

Mark only one oval per row.

Not at all	To a little extent	Neutral	To some extent	To a greater extent
------------	--------------------	---------	----------------	---------------------

The profile of IS department does not require the use of an SDM.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The adoption and following of SDMs are too complex and too hard to use.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The SDM currently in use in the IS department are adequate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The need for the use of an SDM has been reduced by the experience and expertise of the developers in the IS department.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The adoption and use of SDMs are long-term, whereas the limitations on cost and time are short-term.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The IS department does not adopt an SDM due to the lack of experienced staff.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The environment within the IS department are not suited for the use of SDMs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
SDMs are not adopted in the IS department as there lack commitment from top management.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The learning curve for SDMs are too long.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The financial investment for adopting SDMs are too high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uncertainty regarding the benefits of SDMs are present in the IS department.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No clear objectives exists for the adoption of SDMs in the IS department.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section B (Part 3)

Project

13. 2.2 Project size *

Please indicate the size of the last system development project:
Mark only one oval.

- Small
 - Medium
 - Large
 - Very large
-

14. 2.3 Project criticality *

Please indicate the criticality of the last system development project:
Mark only one oval.

- System failure can result in a loss of comfort
 - System failure can result in a loss of discretionary money
 - System failure can result in a loss of essential money
 - System failure can result in a loss of life
-

15. 2.4 Project Nature *

Please indicate the nature of the system developed:
Mark only one oval.

- New development
 - Upgrade from previous development (the current system is only updated)
 - Complete improvement from previous development (system is completely done over)
-

16. 2.5 Planned system future (maintenance plan) *

Please indicate the planned future of the system developed:
Mark only one oval.

- Maintenance only
 - Minor upgrades
 - Major upgrades
 - New versions based on this version
-

17. **2.6 Project/Development time ***

Please indicate the time it took to complete the last system developed:
Mark only one oval.

- Less than 1 year
 - 1 year or more – less than 2 years
 - 2 years or more – less than 5 years
 - 5 or more years.
-

18. **2.7 External database interaction ***

To what extent is the following types of databases used by/in the system developed?
Mark only one oval per row.

	Not at all	To a little extent	To some extent	To a great extent
Network database	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hierarchal database	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Relational database	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Object-oriented database	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Object relational database	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Data warehouse	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. **2.8 External systems interaction ***

With how many external systems (other than the one developed) did the developed system interact with?
Mark only one oval.

- None
 - 1 – 2 systems
 - 3 – 4 systems
 - 5 or more systems
-

20. **2.9 Platform of system developed ***

Which of the following type of system does the system developed match the best?
Mark only one oval.

- Desktop application
- Web based application
- Mobile application

Section B (Part 4)

Project

2.10 To what extent do you agree with the following statements from the last development project you were involved with?

21. Problem complexity *

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The project recognized the level of complexity of the system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system developed was of a complex nature.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The problem complexity was very high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

22. Project cost limitations *

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Cost limitations were present in the budget for the development of the system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Limitations on the cost of the system suppressed the development of the system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23. **Project time limitation ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Adequate time has been given for the development of the system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The time assigned to each task has been enough.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

24. **Change management ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Changes requested to the system developed were managed effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unexpected crises and deviations were present in the development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The unexpected crises and deviations were managed effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

25. **Development team ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The development team had high experience in the use of the chosen SDM.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project team was very cooperative during development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The team was distributed over the country/world when the systems was developed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team members communicated through technology while busy developing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

26. **Tools and techniques ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Appropriate development tools (CASE tools) were used for development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Appropriate development techniques were used.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

27. Requirements *

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Users changed the requirements of the system regularly during the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The requirements from users were understandable to the developers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conflicting user requirements were present during the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

28. Goals and vision *

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Clear goals was set before and was evident during the development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A clear vision and clear objectives was present on the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The goals and vision was mutually agreed upon between the team and all the stakeholders.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

29. **Legacy support ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The system involved technologies with which the developers were familiar with.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The development team had high levels of expertise in development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When knowledge lacked, training was done/given to gain the appropriate knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

30. **Maintenance ***

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The developed system included a well-defined maintenance plan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section B (Part 5)

Project

Regarding the outcome of the last project where a system was developed:

31. 2.11 Project outcome *

Which statement best describe the outcome of the last system development project where a system was developed?

Mark only one oval.

The project was terminated/cancelled before time. *Skip to question 35.*

The project was completed, but not implemented. *Skip to question 33.*

The project was completed, implemented, but are no longer in use. *Skip to question 33.*

The project was completed, implemented, and are still in use. *Skip to question 32.*

Section B (Part 5.1)

Project

32. 2.11.1 System usage *

Please state how many months the system is in use:

Skip to question 34.

Section B (Part 5.2)

Project

33. *

To what extent do you agree with the following statements?

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The project had a well-planned installation and adoption of the developed system in user departments.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project had timely provision of comprehensive control information at each stage in the implementation process.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip to question 34.

Section B (Part 5.3)

Project

34. Project outcome *

To what extent do you agree with the following statements?
Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The project was completed on schedule.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project was completed before schedule.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project was completed within budget.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project was completed under budget.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The developed system satisfied all the requirements stated.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The speed at which new applications were developed was high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project had high productivity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost regarding the development of the system is low when compared to the size and the complexity of the system developed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system developed achieved the goal the system was first intended for.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The project overall represents excellent work done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The overall status of the project are that the project was a success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip to question 35.

Section B (Part 6)

Project

35. **2.12 Project duration ***

Please indicate the average duration of the last system development project:

Mark only one oval.

- Less than 1 year
 - 1 year or more – less than 2 years
 - 2 years or more – less than 5 years
 - 5 or more years.
-

36. **2.13 Team size ***

Indicate the average size of the team who worked on the system developed:

Mark only one oval.

- Less than 7 people
 - 8 – 15 people
 - 16 – 25 people
 - 26 or more people
-

37. 2.14 Usability of the system *

To what extent do you agree with the following statements about the last project you were involved with? (1 is "Totally disagree" and 5 is "Totally agree")

Mark only one oval per row.

	1	2	3	4	5
The functionality of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The reliability of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The maintainability of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The portability of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The efficiency of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The usability of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The developed system meets the user needs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The documentation of the developed system is good.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, the quality of the developed system is high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, the users are satisfied with the developed system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, the developed system is a success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section C (Part 1)

Organizational / Information Systems Department (ISD)

38. 3.1 Organization sector *

Please indicate the sector your organization fall into:

Mark only one oval.

- Computer vendor
 - Mining
 - Manufacturing
 - Electricity and water supply
 - Consulting
 - Tertiary sector
 - System Development
 - Transport and communication
 - Community services
 - Financial / Banking
 - Government
 - Other: _____
-

39. 3.2 Organization/ISD size *

Please indicate the size of your organization/ISD (Information System Department):

Mark only one oval.

- Less than 10 employees
 - 11 – 100 employees
 - 101 – 500 employees
 - 501 – 2000 employees
 - 2001 or more employees
-

40. **3.3 Organization age ***

Please indicate the age of your organization:
Mark only one oval.

- Less than 5 years
 - 5 years or more – less than 10 years
 - 10 years or more – less than 15 years
 - 15 years or more – less than 20 years
 - 20 years or more – less than 25 years
 - 25 years or more – less than 30 years
 - 30 or more years
-

41. **3.4 Organization culture ***

To what extent do you agree with the following statements? (1 is "Totally disagree" and 5 is "Totally agree")

Mark only one oval per row.

	1	2	3	4	5
The IS department I work in, is a very personal place. It is like an extended family and people seem to share a lot of themselves.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The IS department I work in, is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The IS department I work in, is a very formal and structured place. People pay attention to bureaucratic procedures to get things done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The IS department I work in, is a very production oriented place. People are concerned with getting the job done and are not very personally involved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The glue that holds the IS department I work in together, is loyalty and tradition. Commitment to the IS department I work in runs high.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The glue that holds the IS department I work in together, is commitment to innovation and development. There is an emphasis on being first with products and services.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The glue that holds the IS department I work in together, is formal rules and policies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Following rules and maintaining a smooth-running institution are important.

The glue that holds the IS department I work in together, is an emphasis on tasks and goal accomplishment. A production and achievement orientation is commonly shared.

The IS department I work in, emphasizes human resources. High morale in the IS department is important.

The IS department I work in, emphasizes growth through acquiring new resources. Acquiring new products/services to meet new challenges is important.

The IS department I work in, emphasizes permanence and stability. Efficient, smooth operations are important.

The IS department I work in, emphasizes competitive actions, outcomes and achievement. Accomplishing measurable goals is important.

The IS department I work in, is under threat of being disbanded.

The future of the IS department in our organization is uncertain.

42. **3.5 Methodology usage time ***

Indicate how many years your organization/IS have experience in the use of methodologies:

Mark only one oval.

- Less than one year
- 1 year or more – less than 2 years
- 2 years or more – less than 5 years
- 5 years or more – less than 10 years
- 10 or more years

Section C (Part 2)

Organizational / Information Systems Department (ISD)

43. 3.6 SDM Tailoring

To what extent did the IS department tailor the following SDMs for the project? (1 is "Totally disagree" and 5 is "Totally agree")

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
System Development Life Cycle (SDLC)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Structured Analysis, Design and Implementation of Information Systems (STRADIS)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rapid application development (RAD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unified Modeling Language (UML)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Web site design method (WSDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Structured Systems Analysis and Design Method (SSADM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Object oriented hypermedia design method (OO-HDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hypermedia design method (HDM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soft Systems Methodology (SSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Object Modeling Technique by Rumbaugh (OMT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yourdon Systems Method (YSM)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
LBMS system development method	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jackson Systems Development (JSD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Merise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Information Engineering (IE)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Extreme Programming (XP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scrum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

44. If chosen "Other", please specify:

Section C (Part 3)

Organizational / Information Systems Department (ISD)

45. 3.7 Adoption of SDMs

If you did not use a SDM on the last development project, which of the following statements describe the non-use of SDMs most accurately:
Mark only one oval.

- The IS department have never considered using SDMs.
- The IS department have investigated some SDMs, but decided against the use thereof.
- The IS department have used some SDMs in the past, but not anymore.

46. 3.8 Strictness of SDM usage:

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
Adapted on project-by-project basis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A general guideline for all projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A standard which is followed rigorously for all projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

47. 3.9 Regarding the SDM used/adopted in the last system development project:

Mark only one oval per row.

	Not at all	To a little extent	Neutral	To some extent	To a greater extent
The ISDM used are appropriate for the development of the systems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Some changes should be made before the ISDM could be used again.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The ISDM should undergo major changes before it could be used again.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The ISDM is not suited for further development project within the IS department.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Annexure C

Responses per group/forum

The following table provides a list of the groups and forums used to collect data for this study. Each group or forum had its own Google Forum questionnaire, making it possible to record the number of clicks on the URL to the questionnaire, as well as the number of responses gathered from each group or forum.

Platform	Group/Forum	URL	Clicks	Responses
E-mails		http://goo.gl/forms/BuWQ5GDSeS	178	66
Cover letter		https://goo.gl/1aXjAU	494	-
LinkedIn	C# .NET	http://goo.gl/forms/K49ob6CY5A	16	2
LinkedIn	IT Specialist Group	http://goo.gl/forms/2pZopFUBh8	19	2
LinkedIn	IS Business Analyst	http://goo.gl/forms/8XtyHkmxzS	24	3
LinkedIn	IT Professional – Software Engineer	http://goo.gl/forms/gQLCOHx1yx	29	6
LinkedIn	IT Specialist Enterprise Group	http://goo.gl/forms/nxneqvXUUq	14	3
LinkedIn	Programmers and Developers	http://goo.gl/forms/e8A2qu21xZ	8	4
LinkedIn	Programmers and Developers (clean)	http://goo.gl/forms/fzCvJV8Qlp	30	10
LinkedIn	Software and Web Developers is SA	http://goo.gl/forms/xcp6QcpP3I	65	20
LinkedIn	Software Developer	http://goo.gl/forms/qhYPIH0dDy	57	14
LinkedIn	Project Managers Network	http://goo.gl/forms/VxvC2aX8t9	7	4
LinkedIn	IT Project Managers	http://goo.gl/forms/OsldFJkCEt	10	2
LinkedIn	IT Specialists	http://goo.gl/forms/mTB9rR4v57	24	9

LinkedIn	Global Information Technology Professionals Association	http://goo.gl/forms/bTj8HPu3gb	2	1
LinkedIn	IT Managers Group	http://goo.gl/forms/plkuxE3OWH	13	6
LinkedIn	Software Development Professionals Group	http://goo.gl/forms/LMhV0o5Rcp	25	9
LinkedIn	Information Technology	http://goo.gl/forms/uV5DWQfykJ	10	2
Facebook	IT Pros	http://goo.gl/forms/Xyc1OYpWLN	0	0
Facebook	Agile Congress	http://goo.gl/forms/gMwFMdVtNR	0	0
Facebook	Software Developer Community	http://goo.gl/forms/AN4ujfvlm9	1	0
Facebook	Software Developers	http://goo.gl/forms/tN6CRMK0gH	1	0
Facebook	Software Analysts Corporation	http://goo.gl/forms/f4E2YHIESs	0	0
Facebook	Future Analysts and Software Developers	http://goo.gl/forms/K9zFo9ecyj	0	0
Facebook	Information Technology	http://goo.gl/forms/eabcBJJ2gD	0	0
Forum	TomsHardware	http://goo.gl/forms/VQjWmygSwS	0	0
Forum	Dream.In.Code	http://goo.gl/forms/gBF41Sbyny	3	0
Forum	ModernAnalysts.com	http://goo.gl/forms/upKkz4C2jD	0	0
Forum	The IET	http://goo.gl/forms/NNQx0IMZkS	1	0
Forum	PMKB (Project Management Knowledge Body)	http://goo.gl/forms/sugsCo8qGE	0	0
Forum	MyBroadband	http://goo.gl/forms/W7aY6t3599	5	1
Forum	Bytes.com	http://goo.gl/forms/NMDA4Rcl0i	3	0
Forum	GeeksToGo	http://goo.gl/forms/JfoKEOgjLn	2	1
Forum	TechGuy	http://goo.gl/forms/c5HikqeqYE	5	0
Forum	DaniWeb	http://goo.gl/forms/RH7Ptzna1F	4	1

Forum	TechArena	http://goo.gl/forms/07pFHyP7c9	0	0
Forum	Amazon – Software Development	http://goo.gl/forms/Ous8DyA0DQ	0	0
Forum	DreamHost	http://goo.gl/forms/8Xwqzvlrns	1	0
Forum	Yahoo Group (Software Development and Testing Professionals)	http://goo.gl/forms/E2vJgDSOqY	1	0
Forum	ProjectSmart[2015]	http://goo.gl/forms/iuxe6NCAzG	2	0

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Annexure D

Acknowledgement of language editing

Acknowledgment of Language Editing

Date: Monday, 30 November 2015

This is to certify that I have conducted Language Editing on the following thesis:

The selection and use of system development methodologies

BY Jaco Viljoen

Algraham

Andrew Graham (BA, MA dist., PhD, University of Keele, UK)*



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