The use and effectiveness of project management methodologies in mobile application development

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ABSTRACT

This study aims to fill the gap in managing mobile applications with certain project management methodologies (PMM) by looking at different kinds of PMMs and comparing them to characteristics of mobile applications.

To achieve this, an in-depth literature review of project management methodologies was conducted. The different types of PMMs (Agile, PRINCE2, PMBOK and COBIT) were given with each of their processes. An in-depth literature review of mobile application development was conducted. Mobile application history was given together with a description of different types of platforms. Different characteristics were selected from the literature for mobile application development. These characteristics were placed in table format and used to compare the above-mentioned PMMs based on a scoring system. This was done to determine how each PMM addresses each characteristic.

The research was conducted by using a mixed methods design with a combination of both the interpretive and the positivistic paradigms. Each research paradigm was described in full with the given research methods (survey and interviews), quantitative and qualitative data collection techniques (questionnaire and interviews) and data analysis techniques (statistical and content analysis).

The results were given for each of the above-mentioned paradigms (quantitative and qualitative). The quantitative results were achieved by conducting descriptive analysis, reliability testing, factor analysis and t-tests. The qualitative results were produced by conducting content analysis.

This study concludes that MAD is still growing and is successful in South Africa. The resulting processes and products produced by mobile application development are less successful than those produced during traditional system development. Process and product success may be higher if a project management methodology is used. Project managers need to consider using APMM and not traditional PMMs when developing MAD. Project managers tend to use a PMM for various reasons: Fast, flexible, efficient, and adaptable, helps with time and budget management, change management and

based on the complexity of the project. The lack of support from the company and the no-need for a PMM is one of the biggest reasons for not using a PMM.

Keywords: Project management methodologies; Mobile application development; Project management; Use and effectiveness in MAD; Product success; Process success; Developers.

OPSOMMING

Hierdie studie beoog om die gaping in die bestuur van mobiele toepassings met sekere projekbestuur metodologieë (PMM) te vul deur te kyk na verskillende soorte PMMs en hulle te vergelyk met eienskappe van mobiele toepassings.

Om dit te bereik, was 'n in-diepte literatuurstudie van projekbestuurmetodologieë gedoen. Die verskillende tipes PMMs (Agile, PRINCE2, PMBOK en COBIT) word gegee met elkeen se prosesse. 'n In-diepte literatuuroorsig van mobiele toepassings-ontwikkeling was gedoen. Mobiele toepassingsgeskiedenis was gegee saam met 'n beskrywing van die verskillende tipes platforms. Verskillende eienskappe was gekies uit die literatuur vir mobiele toepassingsontwikkeling. Hierdie eienskappe is in tabelvorm geplaas en word gebruik om die bogenoemde PMMs op ‘n puntestelsel te vergelyk. Dit is gedoen om te bepaal hoe elke PMM hierdie eienskappe aanspreek.

Die navorsing is gedoen deur die gebruik van 'n gemengde metodes ontwerp met 'n kombinasie van interpretatiewe en positivistiese paradigmas. Elke navorsingsparadigma is ten volle beskryf met die bepaalde navorsingsmetodes (opname en onderhoude), kwantitatiewe en kwalitatiewe data-insamelings tegnieke (vraelyste en onderhoude) en data-analise tegnieke (statistiese en inhoud-analise).

Die resultate vir elk van die bogenoemde paradigmas (kwantitatief en kwalitatief) word gegee. Die kwantitatiewe resultate is verkry deur beskrywende statistieke, betroubaarheidtoetsing, faktoranalise en t-toetse. Die kwalitatiewe resultate was verkry deur die uitvoer van inhoud-analise.

Hierdie studie kom tot die gevolgtrekking dat MAD steeds groei en is suksesvol in Suid-Afrika. Die prosesse en produkte wat deur mobiele toepassings ontwikkeling ontwikkel word minder suksesvol is as dié wat tydens die tradisionele stelselontwikkeling ontwikkel word. Die proses- en produksukses mag hoër wees as 'n projekbestuurmetodologie gebruik word. Projekbestuurders moet oorweeg om ‘n APMM te gebruik en nie tradisionele PMMs vir die ontwikkeling van MAD. Projekbestuurders is geneig om 'n PMM vir verskeie redes te gebruik: Dit sluit in dat dit vinnig, buigbaar,

doeltreffend en aanpasbaar is. Dit help met die tyd- en begrotingsbestuur en die veranderingsbestuur vir die kompleksiteit van die projek. Die gebrek aan ondersteuning van die maatskappy en die nie-behoefte aan 'n PMM is een van die grootste redes vir nie gebruik van 'n PMM.

Keywords: Projekbestuurmetodologieë; Mobiele toepassingontwikkeling; Projekbestuur; Gebruik en doeltreffendheid in MAD; Produksukses; Prosessukses; Ontwikkelaars.

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“I lean not on my own understanding. My life is in the hands of Jesus Christ my saviour”

Most importantly my heavenly Father, Jesus Christ. All the honour and praise go to Christ alone for the opportunities He has given me in my life. The perseverance to keep going no matter what the cost. To catch me and help me up whenever I stumbled and fall.

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LIST OF ACRONYMS

APMM	Agile Project Management Methodology
COBIT	Control Objectives for Information and Related Technology
IS	Information Systems
IT	Information Technology
MAD	Mobile Application Development
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMM	Project Management Methodology
PMMs	Project Management Methodologies
PRINCE2	PRoject IN Controlled Environment

CHAPTER 1
INTRODUCTION

The aim of this chapter is to provide the problem statement for this study, research aims and objectives, methods of investigation and lastly a chapter division of what is to be expected further on.

1.1 Problem statement

Mobile technology plays a critical role in modern society where mobile computers outnumber personal computers (Bosomworth, 2015). For years professional bodies have developed various methods and techniques to aid in project management, but still many projects fail (Chin & Spowage, 2010:115). Faeth (2013) found that between 65% and 80% of projects fail to meet their objectives. These projects either cost more than planned or are delivered late. Lewis (2014) adds that there are various reasons why projects fail, namely lack of support from management, the project does not align with the company's goals and objectives and unrealistic expectations are set. Another reason for the failure of projects is provided by Charvat (2006:21) and Ziehl and Pecora (2008:145). They state that project management methodologies that are used today are used incorrectly and are not applied fully to the particular project. The tendency among managers is that when the project becomes too complex, they tend to use shortcuts and this will result in the failure of the project. Implementing the right project management methodology enhances the probability that the project team will deliver the end product to the satisfaction of the requirements set forth by the clients (Johnson and Wierschem, 2005:649).

Mobile applications are undergoing rapid expansion in the world today with platforms that continue to improve in performance (Spataru, 2010:1). According to Royce (2012) and Abrahamsson *et al.* (2004:174), the developing teams are faced with challenges every day. Abrahamsson (2005:22) explains that mobile applications are medium-sized, co-located and delivered in rapid releases in order to meet market demands. In order for

these requirements and demands to be met, a project management methodology needs to be implemented so that the outcomes can be achieved and managed.

Wasserman (2010:1) states the more complex mobile applications become, the more the need grows to find an appropriate way of managing the increasingly complex projects. The complexity of projects demands greater attention to the changing requirements, product architectures and testing with the key project properties. These properties include robustness, usability and reliability. Wasserman (2010:1) further adds that the developers of mobile applications should not just be aware of the mobile application properties as a whole, but should also address the project management method issues and the unique aspects of mobile application development. Ramadath (2012) states that determining the project management methodology is the fundamental key to mobile application development success in a cross-platform environment. This is important because many simultaneous tasks are being undertaken.

Although it is clear that developers must use a project management methodology (PMM) while developing mobile application software, there is not enough evidence that it is actually used. After extensive searches no references could be found that PMMs are compared / combined / used with mobile application development (MAD). The only knowledge on this topic is that MAD is compared and used within system development methodologies.

This study will focus on the use and effectiveness of project management methodologies in mobile application development. This study will contribute to two areas: firstly to help developers successfully deliver mobile applications and secondly to increase the body of knowledge on PMM and MAD in academics.

1.2 Research aims and objectives

The aim of this study is to investigate the use and effectiveness of project management methodologies in mobile application development. To accomplish this, the following research objectives will be addressed:

1. Determine the current status of mobile application development in South Africa.

2. Determine the success of mobile application development in South Africa.
3. Determine the use of project management methodologies (if any) in mobile application development.
4. If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.
5. If project management methodologies are used, determine how intensely, widely and strictly they are used.
6. If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.
7. If project management methodologies are used, how effectively are they used?

1.3 Methods of investigation

In this section the research design, participants for this study, data acquisition and instruments and data processing (quantitative and qualitative data) are discussed.

1.3.1 Research Design

Mixed methods design will be used in this study (a combination of positivistic and interpretive paradigm research). For the positivistic paradigm a survey is best suited for this type of study as far as the mobile programmers are concerned. For the interpretive paradigm, interviews will be conducted with the project managers.

1.3.2 Participants

There will be two types of people (participants) who will take part in this study. The first will be project managers and the second will be the mobile developers.

1.3.3 Data Acquisition and Instruments

In order to gather the data, questionnaires will be used and interviews will be conducted with the participants. The interviews will be conducted with the project managers and

the questionnaires will be completed by the mobile developers. Furthermore, the data will include the documentation of the participating company.

1.3.4 Data Processing

There are two sets of data, qualitative and quantitative, that need to be processed accordingly.

Quantitative data

To analyse the quantitative data that was obtained from the questionnaires, the following statistical techniques will be used:

- Descriptive Statistics

Descriptive statistics will be used to summarize and describe the important characteristics of a set of measurements (Mendenhall *et al.,* 2013:4). The measurements used is only used for the sample of the study and not the entire population.

- Factor Analysis

Factor analysis is a collection of techniques used to identify various variables that can be grouped together and used as one variable (Cramer, 2003:13). According to Foster *et al*. (2006:72) there are three requirements that complemented the data by the use of factor analysis:

- Measuring the data using scales,
- Scores varied on variables,
- Variables have correlation.

For achieving this the Kaiser creation will be used for values of the PCA which is greater than 1 (Cramer, 2006:18), after which the rotation will be used. The rotation implements the *oblimin* that shows the indication of each variable to each factors (Cramer, 2003:21).

- Reliability Analysis

Reliability analysis will be done to ensure the consistency and stability of the results found in the questionnaire. The Cronbach alpha is one of the most important statistics when analysing the data (Cortina, 1993:98). The Cronbach alpha's coefficient ranges

between 0 and 1, where 1 indicated the greatest consistency between items (Bland & Altman, 1997:572). The following can be used when interpreting the Cronbach's coefficient (George & Mallery, 2003:231):

- $\propto \geq 0.9$ = Excellent,
- $\propto \geq 0.8$ = Good,
- $\propto \geq 0.7$ = Acceptable,
- $\propto \geq 0.6$ = Questionable,
- $\propto \geq 0.5$ = Poor,
- $\propto \leq 0.5$ = Unacceptable.

This coefficients will be used to determine consistency and stability of the data.

- Effect size and t-test

Spearman's Correlation Coefficient indicate the statistical significance of the correlation between variables. The strength of the effect sizes will be used accordingly (Cohen, 1988:17):

- Small effect: $d \geq 0.2$
- Medium effect: $d \geq 0.5$
- Large effect: $d \geq 0.8$

The t-test will be used to test if there is a significant difference between the data gathered.

Qualitative data

Content analysis can be defined as: "*a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns*" (Hsieh & Shannon, 2005:1278). Content analysis will also be used to analyse the qualitative data by using codes for the data that was collected during the interviews and the open questions asked in the questionnaires.

1.4 Chapter division

The structure of what can be expected in each chapter of this study:

Chapter 2: Literature study – Project management methodologies

This chapter will include literature on project management methodologies. This will provide background knowledge on the use of project management methodologies and how this can be applied to better the field of mobile application development. This chapter will also include: definitions, benefits, concepts, classifications, phases and main methodologies.

Chapter 3: Literature study – Mobile application development

In this chapter a review of mobile application development will be done. Research on mobile application development and how the field has evolved with time will be done. This chapter will also include: definitions, concepts, different platforms of mobile applications, challenges and characteristics and a short history of mobile application development.

Chapter 4: Research design

The purpose of this chapter is to explain what type of research design was chosen for this study. Firstly the mixed methods paradigm will be discussed with the two paradigms, positivistic and interpretive, that is included in this study. The quantitative data, from the positivistic paradigm, will be gathered from questionnaires. The qualitative data, from the interpretive paradigm, will be gathered from the interviews conducted and the open questions in the questionnaires. The data analysis methods for each of these paradigms will be discussed.

Chapter 5: Results – Quantitative

This chapter will include the quantitative results gathered from the questionnaires. Descriptive analysis, reliability, factor analysis and t-tests will be the data analysis methods used for the applicable data.

Chapter 6: Results – Qualitative

This chapter will include the qualitative results from both the interviews and the open questions asked in the questionnaire. Content analysis will be used to analyse the data.

Chapter 7: Conclusion

The conclusions drawn from the results, discussions, literature study, and research method will be given in an effort to achieve the objectives stated above. The limitations of the study will be pointed out, the contributions made to the industry and the academics and lastly the future work of this study will be given.

In this chapter the problem statement for this study was stated and the aims and objectives were set. The method of investigation was given with a chapter division of the whole study. In the next chapter the first part of the literature review on project management methodologies will be carried out.

CHAPTER 2
PROJECT MANAGEMENT METHODOLOGIES

The main focus of this chapter is project management methodologies. This will include the different parts that a PMM comprises, the different types of PMM that are mostly used today and then lastly, the comparison of these different types of PMM. Each type of PMM will be discussed in detail to give a broad view of what the PMM does and where every aspect of the PMM fits in a project.

2.1 What is PMM?

A Project Management Methodology is a tool to help with managing large scale applications (Josler & Burger, 2005:25). When looking at the term Project Management Methodology, it becomes clear that the term is made up of three separate parts, namely: **Project, Project Management** and **Methodology**. These terms can be defined as the following:

2.1.1 Project

"A Project is a temporary endeavour undertaken to create a unique product, service, or result" according to PMBOK (2013:3) or in the words of Emerson (2006:30), "A *Project is an endeavour that has a finite timeframe and creates a service, product, or result*". This states that a project is a temporary action that has a start and an end. The project will only be approved to start if there is a need that must be filled and if the project is beneficial to the organization. A project will reach its end, if and only if, the objectives set forth by the project team are met or if the project is terminated due to objectives that are not met. The word 'temporary' does not refer to a project that has a short cycle, it refers to the project that will start and finish within a certain space of time (PMBOK, 2013:3; Emerson, 2006:30).

In this study a project is defined as follows:

"A project is an individual or collaborative initiative to create a unique product or service with a particular goal, that has a begin and an end time"

2.1.2 Project Management (PM)

Project Management has become an essential part in achieving business goals as well as the delivery of successful projects across the entire industrial sector (Chin *et al*., 2012; Crawford, 2005:7). When defining Project Management in an informal manner, the words of Drucker (2001:4) come to mind when he defines PM as*: "to make people capable of joint performance through common goals, common values, the right structure, and the training and development they need to perform and respond to change".* PMBOK (2013:5*)* defines Project Management as*: "Project Management is the application of knowledge, skills, tools and techniques to project activities to meet the project requirement".* PM is a process that consists of managing a specific project that must have a manager to take the lead. PM incorporates skill, knowledge, activities, tools and techniques that are needed to reach the project goals set by the organizational stakeholders (Emerson, 2006:31).

Just as times change and new and updated data comes to light, PMBOK has come forth with a set of new processes and knowledge areas (which will be added and explained later).

2.1.3 Methodology

"A Methodology is a set of guidelines or principles that can be tailored and applied to a specific situation. In a project environment, these guidelines might be a list of things to do. A methodology could also be a specific approach, templates, forms and even checklists used over the project life cycle." (Charvat, 2003:14).

According to Turbit (2004:3-4), a methodology must consist of the criteria captured in Table 2-1:

Table 2-1 Important factors a methodology must cover (Turbit, 2004:3-4)

Criteria	Description
Breakdown	Overall broken down into smaller manageable phases
Overview	The purpose, objectives, deliverables and timeframe

Activities	What are the main focus activities
Input & Outputs	Each activities prerequisite's inputs. Each activities deliverables.
Instructions	How will each activity be carried out?
Participants	Who will be participating in each activity?
Supporting Materials	Tools, checklists, templates and any other materials that can be beneficial to assist each activity
QA	How will quality assurance be managed?
Timing	Estimate of each activity
Governance	The signoffs, applicable authorities involved, approvals and mandatory activities.

From Table 2-1 it can be concluded that there are various criteria that a methodology must consist of. No criteria is more important than the other. Each criteria needs to be considered when developing a methodology.

2.1.4 Project Management Methodology

In the above discussion we explained the terms project, project management and methodology. In this section all three these separate parts will be combined to form one entity named project management methodologies (PMM).

According to Turbit (2004:2) there are key concepts to remember when using a PMM:

- A PMM indicates that a project should be broken down into phases and that a plan for each phase should exist before the project begins.
- A PMM defines roles and responsibilities for people involved in the project.
- A PMM provides guidelines for a budget and how the budget should be managed.
- The PMM itself is a framework, as discussed later.

In the industry today there are many PMM definitions. To understand PMM one has to understand the definition. In Table 2-2 different definitions of PMM are described, as well as the benefits of choosing a PMM:

Table 2-2 Definitions of Project Management Methodologies and the Benefits they are associated with

Definition	Benefits
"Project Management Methodology is to provide a standard method and guidelines to ensure that projects are completed on time and within a budget and are conducted in a disciplined, well-managed, and consistent manner that serves to promote the delivery of quality products and results" (Charvat, 2003:60).	• Better Process • Standard Approach • Consistency • Better Planning • Better Quality Focus • Better Flexibility
"*A project management methodology is a structured guide or framework designed to help organizations manage large and small projects in a controlled and efficient manner*" (Gardiner, 2005:45).	• Reduces Communication and integration problem throughout the project life cycle
"Project Management Methodology *is a strictly defined combination of logically related practices, methods and processes that determine how best to plan, develop, control and deliver a project throughout the continuous implementation process until successful completion and termination. It is a scientifically-proven, systematic and disciplined approach to project design, execution and completion*" (McConnell, 2010).	• Cost estimates are complete, accurate and credible • Conflicts are spotted and resolved early • Tasks done effectively • Solutions quickly implemented
"A *project management methodology addresses the principles and procedures for performing project management, where project management is a critical value-adding process that improves the probability of project success*" (Wells, 2012:56).	• Increases efficiency & productivity • Improved Quality • Reduces risk of project failure • Improved communication
"*Project management methodology is the means to provide a set of guidelines and ways to make sure that when a project is started that it is completed on time and within the budget that is set forth. It needs to be managed in a way*	

that the final end product is of the highest quality and accurate results" Josler & Burger (2005:25).	

Chin and Spowage (2010:2) came up with a graphical description of a Project Management Methodology:

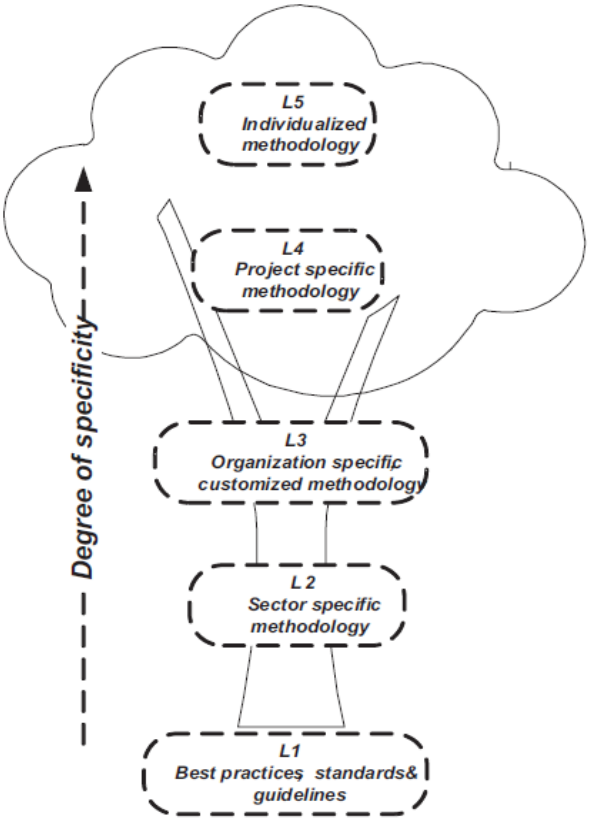


Figure 2-1 Visual representation of Project Management Methodologies (Chin & Spowage, 2010:2)

At the University of Nottingham's Malaysian Campus Chin and Spowage (2012:3-4) divided project management methodologies into two categories. Within these two categories are five interdependent levels. The two categories include the project management methodologies, which include the high-level framework for every project, and the application development methodologies, which include all the necessary details of every project's design and development. Chin and Spowage (2012:3-4) classify the five levels, which can be seen in Figure 2-1, as:

- L1: Best Practices, Standards and Guidelines

This particular group is commonly referred to as “methodologies”. Most authors support the notion that this group is an encyclopaedia of best practices rather than methodologies that are commonly followed. This category lacks the fundamental characteristics of a true methodology, as stated above. Best practices are very important for they are the source of information for the development of new PMMs.

- L2: Sector Specific Methodologies

  This group focuses on sector specific methodologies. Sector specific methodologies are constructed by the extraction of the appropriate elements form L1 (Best Practices, Standards and Guidelines) and then adding components needed by sector specific rules to map the natural flow of work.

- L3: Organization Specific Customized Methodology

  The focus of this group lies with the specific methodologies that are customized to the organization’s needs. These methodologies are adapted to meet the strategy, structure and the nature of the organization. The implementation of an L3 methodology within an organization requires the integration of project processes with the organization’s business systems. Without these elements the organization will find it difficult to assess the information and this will result in constant administration duplication.

- L4: Project Specific Methodology

  On this level (L4) the methodology must be scalable to meet different project sizes within an organization. This should help:

  - the project team to understand the scope;
  - identify what the project teams have to accomplish;
  - the particular projects fit the goals of the organization;
  - to provide tools and techniques.

  In other words, the normal flow of work within the organization must be mapped with the use of methodology L4 (Project Specific Methodology). In the mapping process it may be required to separate branches of the methodology that are being developed for the particular projects. In the end, the key is to develop a methodology that is specific to the organization and the type of project the

organization takes up. This methodology must be dynamic, flexible and adaptive to any five projects.

- L5: Individualized Methodology

  This group is the highest degree, as seen in Figure 2-1, in the design of the methodology. L5 (Individualized Methodology) is specifically for individual projects. Projects in general are relatively simplistic, but they contain numerous elements of the commercial project. For example, stakeholders, a company that wants specific deliverables and internal and external suppliers to interact with the company system. In addition, the design of an individualized methodology comes from the extraction of the most important yet relevant L4 branches that are specific to the individual project situation.

As can be seen there are quite a few definitions from different sources of PMM. In this particular study, a PMM will be defined as:

“A project management methodology is a combination of strictly well-defined methods and guidelines to determine that the project endeavour will be completed successfully, within the time frame and under the budget that has been set”.

In Figure 2-2 it can be seen that PMBOK’s white paper started as early as 1987, in which basic information was given on the concept. The concept of PRINCE2 was introduced just two years after PMBOK. In 1996 all three PMMs, COBIT, PRINCE2 and PMBOK released their first edition to the public. Making headway, PRINCE2 and COBIT released their second edition in 1998, whereas PMBOK released their second edition two years after that with COBIT’s third edition. The Agile Manifesto originated in 2001. PRINCE2 then released its third edition in 2002, whereas PMBOK’s third edition was released in 2004. It would appear that PMBOK tended to be two years behind the others. Just a year after PMBOK’s third edition COBIT and PRINCE2 released their fourth edition. Three years later PMBOK released its fourth edition. The following year, 2009, PRINCE2 was the first to release its fifth edition. Seven years after COBIT’s last update that was in 2005, it finally released its fifth edition in 2012. Just a year later COBIT updated its fifth edition and released a 5.1 edition with PMBOK’s fifth edition in 2013. To date not one of the PMMs has release a new version. As one can see from the

timeline, the years between the released editions have increased. This can result in a few years passing before the next update.

2.2 Growth of PMM

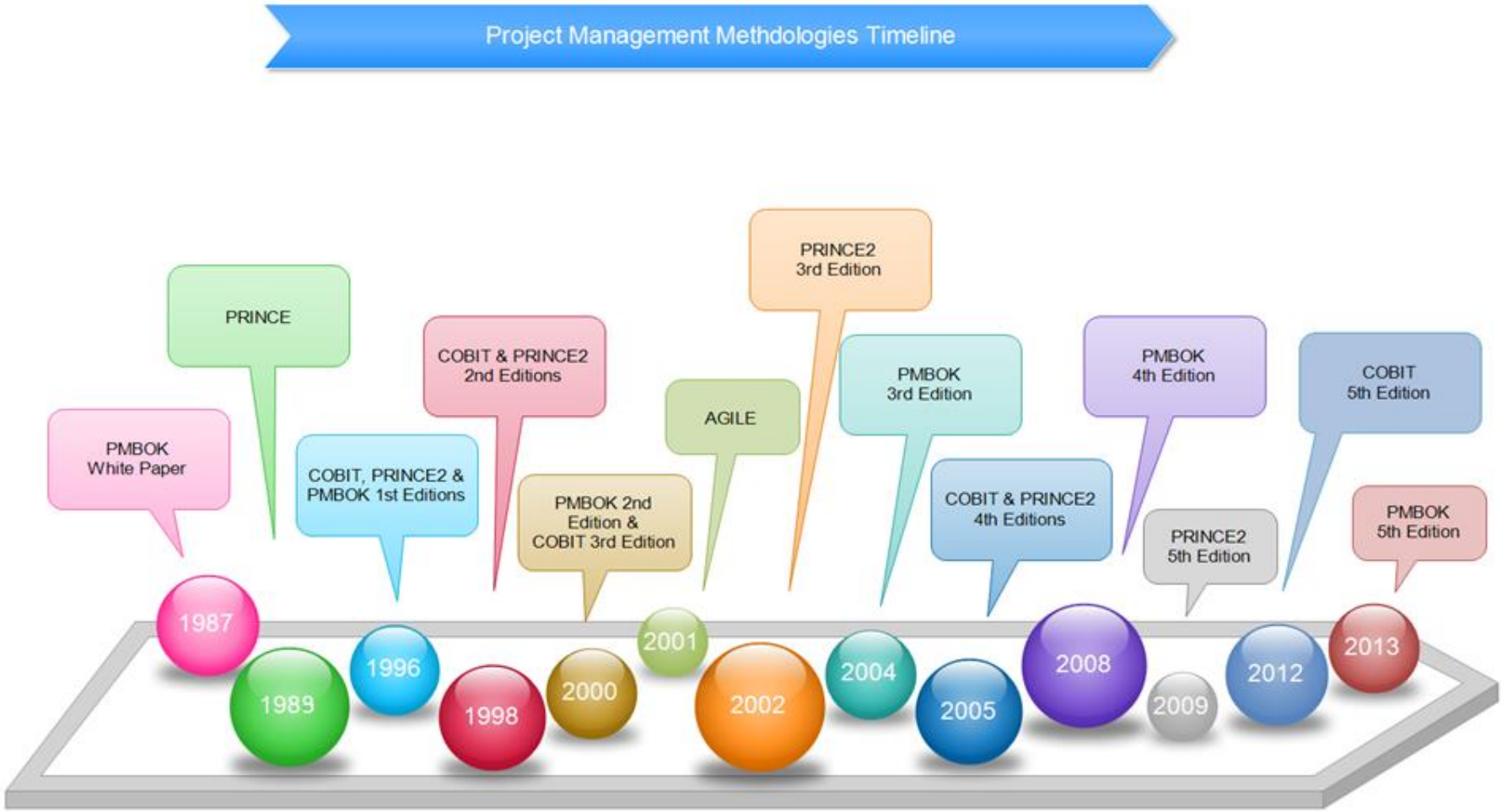


Figure 2-2 Historical timeline of Project Management Methodologies (Anon, 2015b; Andric, 2007; Villegas, 2007; COBIT, 2007; PMBOK, 2013; Meadow, 2012; Anon, 2014b; Phillips, 2012)

2.3 Types of PMM

In the previous section a PMM was defined. Subsequently the different types of PMM will be identified. This section will consist of the identification, description and comparison of each of these PMMs with one another. The PMMs selected are the most used PMMs in the industry today namely Agile, COBIT, PRINCE2 and PMBOK (Goo, 2011).

2.3.1 Agile project management methodologies (APMM)

Agile project management methodology (APMM) made its way into the industry in 2001. From then on APMM is referred to as the modern way of project management processing. The reason for this is because APMM is a set of light-weight activities that is used to manage the development of software (Carayannis *et al.*, 2005:324). These activities include

- Requirements gathering – gathering the data related to the user needs.
- Design specifications – This defines how a system must perform by the outlined requirements.
- Coding (front-end and back-end) – This involves the actual coding. Front-end refers to the interaction part with the user. Back-end refers to the procedures and activities generated behind the front-end of the system.
- Testing – To see that the program runs as intended and that it is free from any errors causing the system to fail.

This is the minimal set of activities that is used to present a complete software system to the system owners. APMM also addresses the management aspects in these activities – people, process and technology (Carayannis *et al.*, 2005:325).

Table 2-3 Traditional PMM vs. Agile PMM (Larson & Gray, 2011:585)

Traditional PMM	Agile PMM
Design up front	Continuous design
Fixed Scope	Flexible Scope
Deliverables	Features / requirements

Freeze design as early as possible	Freeze design as late as possible
Low uncertainty	High uncertainty
Avoid change	Embrace change
Low customer interaction	High customer interaction
Conventional project teams	Self-organized project teams

Table 2-3 points out the differences between the traditional PMM and the APMM. One can see that APMM represents a shift from the traditional approach by implementing a more experimental and adaptive approach to the management of projects (Larson & Gray, 2011:585). The traditional PMM is designed to function in a predictable zone and the APMM in an unpredictable zone. The predictable zone represents a project where the scope is well defined and the technology to be used for the particular project is recognized. The unpredictable zone would count as the opposite of the predictable zone (Larson & Gray, 2011:584).

Wells (2012:49-54) investigates the benefits and support provided by PMMs to project managers in Information System (IS) projects. Among other PMMs one of them was Agile PMM. Wells (2012:49-54) found the following regarding agile PMM:

- There is no direct reason to be innovative by selecting Agile, but Agile covers shortcomings in traditional methods.
- There are five core practices that are recognized when it comes to customer requirements when introducing agile, namely:
    - User stories
    - Iterative development
    - Customer involvement
    - Continuous integration
    - Automated testing.
- Agile is not just a methodology, it is about cultural and behavioural change. By this change it is considered to be the change of heart and mind-set.
- Agile values and principles can be applied to many situations.

- Implementing change and promoting agile in a company is not an easy task. There are no rewards when it comes to being an expert agile developer and agile practitioner, whereas with PRINCE2 there are recognized incentives.
- Most interviewees highlighted the benefits of using agile and also complained about traditional approaches.
- There are several benefits to APMM:
    - Speed of delivery
    - Transparency in project activities and progress
    - Beneficial for the software development
    - Requirements definition, prioritization and management.

Problems using APMM was compounded by the behaviours of the methods as well as the participants using this method's behaviour (Carayannis *et al.,* 2005:325). Carayannis *et al.* (2005:324) also state that making a process lightweight and removing some artefacts without careful consideration what the impact may be.is most likely the possible source of project failure

This concludes the discussion of APMM. In the next section the COBIT project management methodology will be discussed.

2.3.2 COBIT

COBIT (Control Objectives for Information and Related Technology) was created by the ISACA (Information Systems Audit and Control Association) together with the ITGI (Information Technology Governance Institute). According to Thomas and Tilke (2007:1), COBIT is one of the three leading formalized project management methodologies that is used today, along with PRINCE2 and PMBOK (which will be discussed later). COBIT consists of 34 high-level objectives for multiple sub-objectives across four domains (Thomas & Tilke, 2007:6; Lainhart, 2001; Von Solms, 2005; COBIT, 2007:25; Thomas, 2013):

Planning and Organization – This domain defines the IT plan and architecture as well as determines the technology direction. It defines the relationships with the organizational processes involved and manages both the human resources and investments with effective communication to the directors. It identifies, manages and controls risks that are applicable to the project.

Acquisition and Implementation – This domain identifies the software and technology thereby enabling operation for acquiring the solutions.

Delivery and Support – This domain defines and manages all the levels of service, which also include third-party services. It manages problems, service desk, incidents and costs and also controls the data and configurations as well as the environment with all the applicable operations.

Monitoring and Evaluation – This domain constantly monitors and controls the performance and controls, thereby providing IT governance and regulatory compliance.

COBIT cube (Figure 2-3) summarises the IT resources that are managed by the IT processes to achieve the set goals, which are related to the business requirements. The cube illustrates the basic principles of the COBIT framework (Figure 2-4) (COBIT: ITGI, 2007:25).

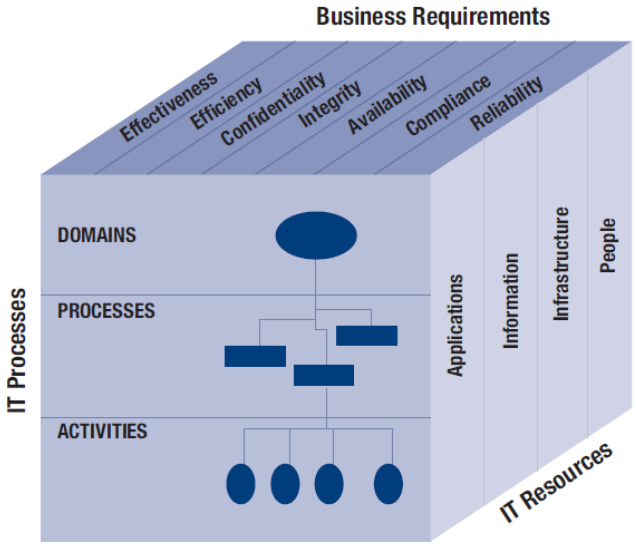


Figure 2-3 COBIT Cube (COBIT: ITGI, 2007:25)

In Figure 2-3 one can see that the COBIT cube is divided in three sections, namely IT Processes, Business Requirements and IT Recourses. Each of these sections has subsections. The business requirements section has the following subsections (COBIT: ITGI, 2007:25; Thomas, 2013):

> Effectiveness – This subsection is concerned with the information regarding the business processes so that they will be delivered on time, correctly, consistently and in a usable manner.

Efficiency – This subsection is responsible for provision of the information through best use of the resources.

Confidentiality – This subsection deals with the sensitive information aspect to ensure that it is protected from unauthorised disclosure.

Integrity – This subsection makes sure that the information is complete and accurate in accordance to the set business values.

Availability – This subsection makes sure that the present and future information is at all times available when it is required by the business process.

Compliance – This subsection is concerned with the laws, regulations and contract arrangements in which the business process is involved.

Reliability – In this subsection reference is made to the management of appropriate information to operate the entity and exercise governance responsibilities.

The next section is the IT resources. To understand the cube, one can see that the IT resources are managed by the IT processes, which will be discussed later, to achieve the IT goals according to the business requirements. The subsections can be defined as:

Applications – These are all the automated user systems and manual procedures.

Information – This is the processed data. The information is gathered through form's input, processed and then provides output by the information system.

Infrastructure – This is the facilities and technology used to enable the processing of the applications.

People – This is the workforce that is needed to plan, organise, acquire, implement, deliver, support, monitor and evaluate the information system and the services concerned.

The third part of the cube is the IT processes with the following subsectors:

Domain – In COBIT there are four domains to govern the IT effectively. One can see this in Figure 2-4 where the cube is explained in a more extensive manner. In Figure 2-4 one can see the subtasks of each domain:

Plan and Organise (PO) – direction to solution delivery

Acquire and Implement (AI) – solutions that turn into services

Deliver and Support (DS) – solutions made useable to end users

Monitor and Evaluate (ME) – Monitors all processes to ensure direction.

Process – Each domain has processes that need to be followed. These processes can be seen in Figure 2-4 under each of the corresponding domains. There is a total of 34 generic processes.

Activities – These activities refer to the subsections of each process to be followed for each domain.

This concludes the discussion of COBIT. In the next section the PRINCE2 project management methodology will be discussed.

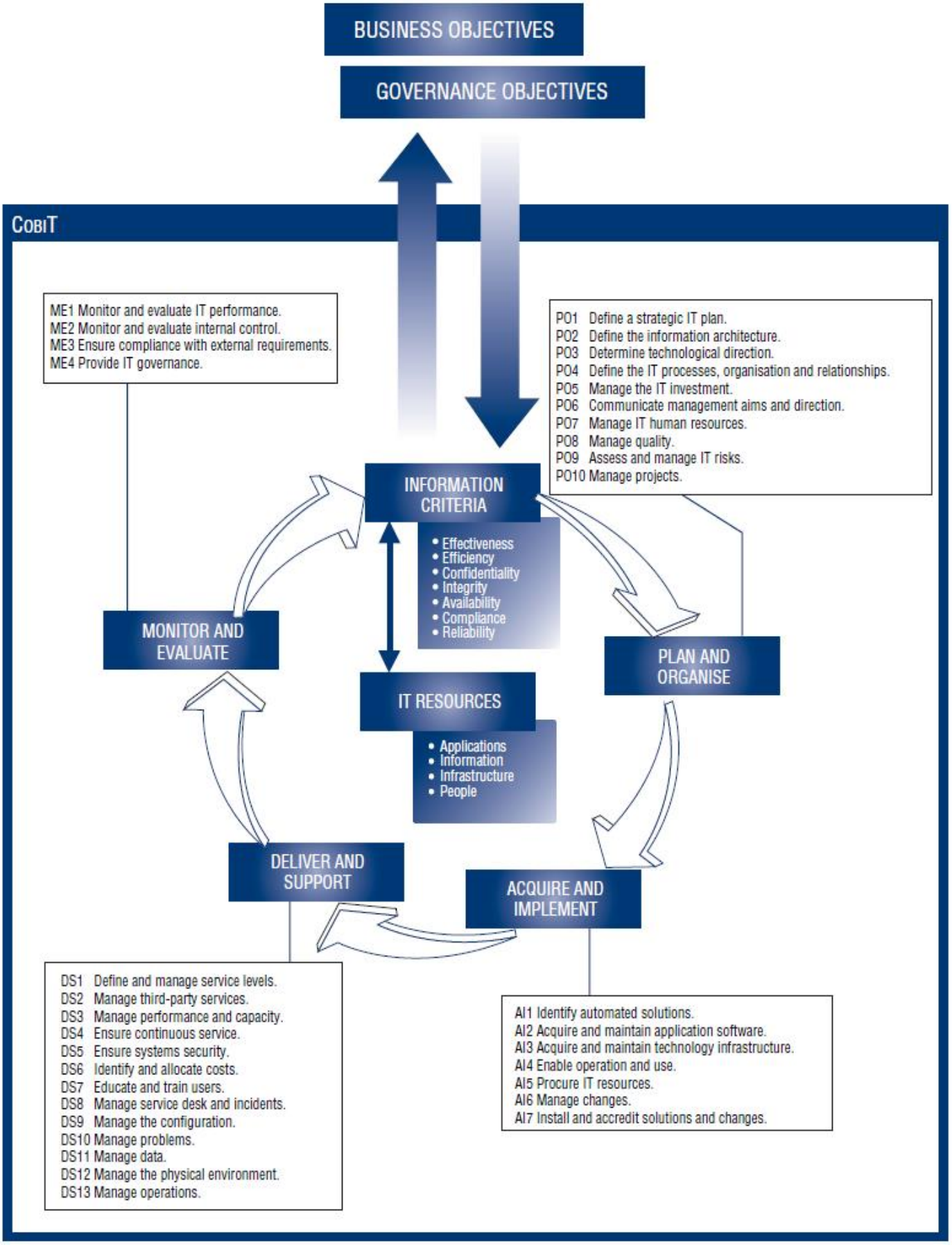


Figure 2-4 COBIT FRAMEWORK (COBIT: ITGI, 2007:26)

2.3.3 PRINCE2

OGC (2009:218) defines PRINCE2 as: "*method for managing projects within a clearly defined framework and it describes a procedure to coordinate people and activities in a project, with guidelines on how to design and supervise the project*" and lists the following benefits when using PRINCE2:

- Effective control of resources.
- Close monitoring of the project in an organized and controlled manner.
- Provides a common language for all participants in the project.
- Describing the management roles and responsibilities.

The PRINCE2 (PRojects IN Controlled Environments) framework was developed in 1989 by the Central Computing and Technology Agency (CCTA) for developing and implementing Information Technology Projects (Charvat, 2003:65; Anon, 2014b; Siegelaub, 2014). This methodology is becoming one of the most popular and companies are starting to adopt this as their main approach towards any project and hiring only PRINCE2-certified managers (Charvat, 2003:65). There are various key features involved in the PRINCE2 method and they include (Anon, 2014b; Bentley, 2010:165; Siegelaub, 2014): product-based planning approach; focuses on business justification; flexibility to be applied to level appropriate to project; focuses on dividing the project into smaller manageable and controllable stages; and defines organizational structure for the project management team.

PRINCE2 is not just about implementing Information Technology projects, but the construction industries have also taken up interest in this method to tailor it to their projects. This method is similar to the Dynamic System Development Methodology (DSDM), but the main difference that is not allocated in other methods is the fact that this method has the concept of 'Assuring Progress' from other perspectives (Charvat, 2003:65).

As previously discussed regarding the study by Wells (2012:49) on the effectiveness of project management methodologies in practice, the following was found on PRINCE2:

- PRINCE2 is by far the most commonly used project management methodology in major countries that include: Australia, New Zealand, Asia, the United Kingdom, India, Hong Kong, and Europe.

- PRINCE2 is prescriptive.
- PRINCE2 has become a standard in most organizations, because PRINCE2 is easily accessible, financially viable and readily available.
- PRINCE2 is a predictive methodology, which means that a decision is made for you.
- PRINCE2 is an exception-based project management method that provides little management interaction.
- PRINCE2 provides steps, methods, procedures and techniques.

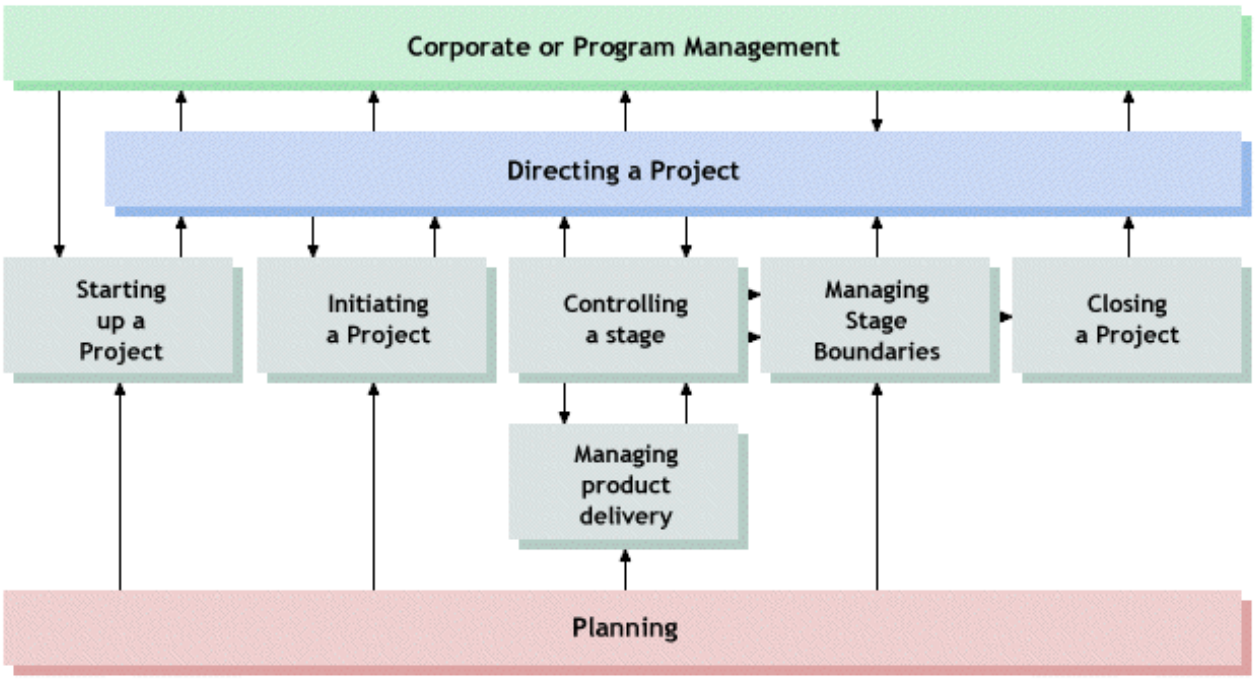


Figure 2-5 PRINCE2 Process Model (Anon, 2014b; Siegelaub, 2014; Wells, 2015)

2.3.3.1 Process Model

Start up a Project – This refers to the controlled start to a project after the project life cycle and the oversight have been done with the viability evaluation as seen in Figure 2-5 (Anon, 2014b; Bentley, 2010:19; Siegelaub 2014).

Directing a Project – The direction of the project occurs throughout the implementation and also defines the responsibilities of the project. This process is the framework for the project manager (Anon, 2014b; Bentley, 2010:57; Siegelaub, 2014).

Initiating a Project – This process will only occur once in the project life cycle, and will give an overall look at the project to be managed (Anon, 2014b; Bentley, 2010:35; Siegelaub, 2014).

Planning – In this process the planning of the project's required deliverables, activities and resources that are needed to create them take place. The use of a common module ensures the concept of a coherent, consistent approach to the planning of the project (Anon, 2014b; Bentley, 2010:36; Siegelaub, 2014).

Controlling a Stage – The controlling stage, as seen in Figure 2-5, is a means to guide the project manager in managing the project daily. It includes all the tasks needed to be set up by the project manager (work authorization, corrective action, analysis and reporting, status collection, etc.). This stage is iterative and needs to be repeated for each developing stage (Anon, 2014b; Bentley, 2010:71; Siegelaub, 2014).

Managing Product Delivery – This is where the individuals, teams and contractors need to agree on the work to be performed. They not only need to complete the work, but must constantly deliver status reports on the current work that is being done (Anon, 2014b; Bentley, 2010:91; Siegelaub, 2014).

Managing Stage Boundaries – This process is the transition from the completed work stage to the start of the next stage. Before moving on, the assurance that the work defined in the stage has been completed must be given (Anon, 2014b; Bentley, 2010:99; Siegelaub, 2014).

Closing a Project – Before a project can be signed off as being 'complete', it must be ensured that the work has been completed to the customer's satisfaction and that expected products handed over to the customer and the support and operations of the project products are in place (Anon, 2014b; Bentley, 2010:133; Siegelaub, 2014).

This concludes the discussion of PRINCE2. In the next section the PMBOK project management methodology will be discussed.

2.3.4 PMBOK

Project Management Body Of Knowledge (PMBOK) provides a set of guidelines for managing projects. It also gives a clear perspective of the managing life cycles and the processes that are involved. PMBOK is a globally recognized and accepted

project management methodology (PMBOK, 2013:1). These processes of PMBOK is guidelines for a project manager to apply to every project of the company to deliver a successful project. The specific knowledge areas of PMBOK are there for better process organizing.

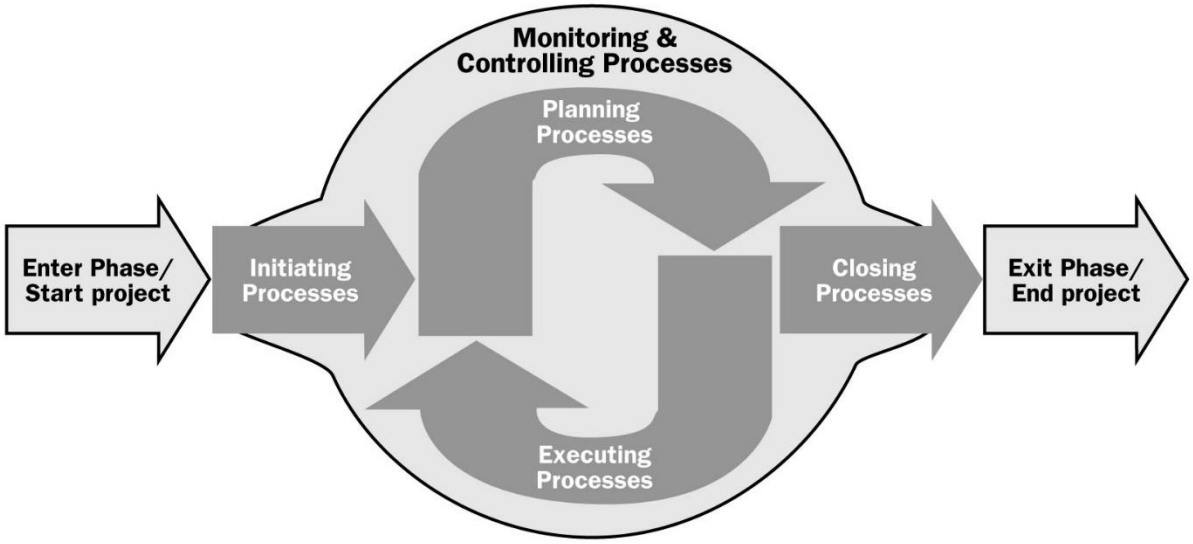


Figure 2-6 Process Groups for PMBOK (PMBOK 2013:50)

The following descriptions are based on Figure 2-6. This figure includes all the process groups of PMBOK from the start of each project to the end of the delivered project.

2.3.4.1 Process Groups

Initiating Processes: The main aim of this phase is to include the basic description of the project scope as well as its duration and deliverables. Involve as many stakeholders as possible, because this will lead to more acceptable project deliverables when more project recipient opinions will be heard earlier in the process. This phase has two main deliverables, namely Project Charter and Project Scope Statement (PMBOK, 2013:49; Emmerson, 2006:41; Pathak, 2014).

Planning Processes: This phase incorporates the planning of the project as seen in Figure 2-6. This jobs lies with the project manager who draws up a list of what needs to be done, who is going to do it and when it must be finished. The high-level scope that was constructed in the Initiating Process is refined in this process to a specific scope classification and the project management plan (PMBOK, 2013:49; Emmerson, 2006:43; Pathak, 2014).

Executing Processes: The main project goals are achieved in this phase. There are six processes in this phase: direct and manage project execution, quality assurance, selecting the project team, develop project team, request seller response, select sellers and information distribution (PMBOK, 2013:49; Emmerson, 2006:47; Pathak, 2014).

Monitoring and Controlling Processes: Figure 2-6 shows how this phase is implemented throughout the whole project. The constant monitoring gives the project team insight into the overall health of the project to see where there are areas that require additional attention. This process includes the collection, measurement, and dissemination of project performance information (PMBOK, 2013:49; Emmerson, 2006:50; Pathak, 2014).

Closing Processes: If and when a project has achieved all its objectives, it can be closed. There are two aspects to this phase: close project, where the project team delivers the final product to the client, and contract closure, finalizing outstanding contracts and closing any administrative aspects of the project that are left (PMBOK, 2013:49; Emmerson, 2006:53; Pathak, 2014).

2.3.4.2 Knowledge Areas

After discussing the process groups of PMBOK the nine knowledge areas will now be discussed. These knowledge areas are responsible for better process organizing.

Integration – This knowledge area ensures that all the processes of the other knowledge area are integrated into one well-organized structure. This can only be accomplished by managing and controlling all the others areas of the project life cycle (PMBOK, 2013:63).

Scope – The scope knowledge area includes all the processes that need to be executed for the project to be completed successfully. The scope primarily consists of the defining and controlling the project. The project scope must include all the work required to be done, what is already done beforehand and what must not be included in the project (PMBOK, 2013:105).

Time – Project time management includes the timely completion of the project. This knowledge area includes the schedule management plan, which means it contains

the estimated time it will take to complete the tasks set out by the stakeholders and project management team (PMBOK, 2013:141).

Cost – This area includes estimating, budgeting, financing, funding and managing the costs of the project, so that the project can be completed within the set budget that was given by the stakeholders, which includes the sponsor (PMBOK, 2013:193).

Quality – The project quality management refers to the processes that determine the quality policies and responsibilities of the project so that they can satisfy the needs of the organizations in the manner in which they are undertaken. The quality management ensures the project requirements are met and validated (PMBOK, 2013:227).

Human Resources – This knowledge area consists of the project team. This is the process that selects, organizes and manages the people assigned. Everyone in the project team is assigned a specific role and responsibilities for completing his/her part of the project. It is the project leader's responsibility to lead the team and to ensure that everyone completes his/her task on time and within budget (PMBOK, 2013:255).

Communications – This process is mainly concerned with the communication between the project team and the stakeholders. This process consists of planning, managing and controlling communication management. According to PMBOK (2013), this communication bridges the gap between diverse stakeholders, which refers to stakeholders with different levels of expertise, perspectives, cultural background, interest, etc. (PMBOK, 2013:287).

Risk – The project risk management includes the identification of the various risks that are involved in the project. This process includes the planning, identity and control of the risks. The identified risks need to be managed so that the likelihood of a positive outcome can be increased and the likelihood of a negative outcome can be decreased in the project (PMBOK, 2013:309).

Procurement – This is the process that analyses what products, services or any other resources need to be purchased outside of the project team. This means that the project team can get any goods from another organization, whether it is a specific product or service, to accomplish the work that has to be done (PMBOK, 2013:355).

Stakeholder – Project Stakeholder Management is the process of identifying the necessary people, groups or organizations that can/could have an impact on the project. This knowledge area also plays the important role of communication with the stakeholders to hear what they want from the project and what the main issues are that need to be taken into account. According to PMBOK (2013:391), "Stakeholder satisfaction should be managed as a key project objective".

Table 2-4 reflects the mapping of all 42 project management processes concerning PMBOK. In the top row of the table one can see the five project management process groups and on the left-hand side the nine project management knowledge areas, as discussed in detail above.

Table 2-4 Project management process group and knowledge area mapping (PMBOK, 2013:61)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
Project Integration Management	Develop Project Charter	Develop Project Management Plan	Direct and Manage Project Work	Monitor and Control Project Work Perform Integrated Change Control	Close Project or Phase
Project Scope Management		Plan Scope Management Collect Requirements Define Scope Create WBS		Validate Scope Control Scope	
Project Time Management		Plan Schedule Management		Control Schedule	

		Define Activities Sequence Activities Estimate Activity Resources Estimate Activity Durations			
Project Cost Management		Plan Cost Management Estimate Costs Determine Budget		Control Costs	
Project Quality Management		Plan Quality Management	Perform Quality Assurance	Control Quality	
Project Human Resource Management		Plan Quality Management	Acquire Project Team Develop Project Team Manage Project Team		
Project Communications Management		Plan Communications Management	Manage Communications	Control Communications	

Project Risk Management		Plan Risk Management Identify Risks Perform Qualitative Risk Analysis Perform Quantitative Risk Analysis Plan Risk Responses		Control Risks	
Project Procurement Management		Plan Procurement Management	Conduct Procurements	Control Procurements	Close Procurements
Project Scope Management	Identify Stakeholders	Plan Stakeholder Management	Manage Stakeholder Engagement	Manage Stakeholder Engagement	

This concludes the discussion of PMBOK. In the next section the comparison of the above discussed PMMs will be given.

2.3.5 Comparison of Agile, PMBOK, PRINCE2 & COBIT

In this section a comparison of Agile, PMBOK, PRINCE2 and COBIT will be given, as seen in Table 2-5.

Table 2-5 Comparison of Agile, PMBOK, PRINCE2 & COBIT

	Agile	PMBOK	PRINCE2	COBIT
Culture	Responsive (Griffiths, 2013)	Descriptive (Ramalho, 2012; Cottino, 2009; Charbonneau, 2004)	Prescriptive (Ramalho, 2012; Cottino, 2009)	Illustrative (COBIT, 2007:14)

Tools	Minimal tools and change over time (Griffiths, 2013)	Project Manager Tool (Ramalho, 2012; AnonCharbonneau, 2004)	Organizational Tool (Ramalho, 2012)	Organizational Tools (COBIT, 2007:120)
Process	Process Orientated (Griffiths, 2013)	Process Orientated (Ramalho, 2012)	Business and Product Orientated (Ramalho, 2012; Trainer, 2010)	Process Oriented (COBIT, 2007:10)
Method	Methodology (Augustine, 2005)	Encyclopaedia (Ramalho, 2012; Cottino, 2009)	Methodology (Ramalho, 2012; Cottino, 2009)	Methodology (COBIT, 2007)
Knowledge	Exploratory (Augustine, 2005)	Detailed Knowledge (Trainer, 2010)	Basic Knowledge (Trainer, 2010)	Expert Knowledge (COBIT, 2007:187)
Project Manager Roles	Guiding Vision - Self Organized Teams (Griffiths, 2013; Augustine, 2005; Larson & Gray 2011:585)	Targeted at Project Managers Role (Cottino,2009; PMBOK, 2013:8)	Covers PM Roles (Cottino, 2009)	Roles of the Process Owner (COBIT, 2007:46)

In Table 2-5 one can see the comparison of all the different types of PMM that were discussed above. One can see that each PMM is unique with its own culture. Looking at the tools one can see that both PRINCE2 and COBIT uses organizational tools, whereas PMBOK uses PM tools and Agile uses minimal tools for each project. Agile, PMBOK and COBIT is all process orientated and just PRINCE2 is business and product orientated. Out of all four PMMs, PMBOK is the only PMM that is classified as an encyclopaedia. The other three PMMs are all methodology based when it comes to the method. Looking at the information in Table 2-5 it is clear that each PMM is unique in its own knowledge and diverse set of project management roles. Charvat (2003:13) points out that there is no such thing as a wrong or right

PMM, it is all about which one best suits your needs and the key is how you as project manager implement the PMM.

After a literature search it is still unclear if any of these PMMs are used in MAD and thus it will be investigated in this study.

In this chapter an in-depth literature review on project management methodologies was given. Definitions and different types of PMM were discussed with a comparison of the four major PMMs that exist. This comparison was a self-constructed table from various sources. In the next chapter an in-depth literature review on mobile application development will be carried out.

CHAPTER 3
MOBILE APPLICATION DEVELOPMENT

In this chapter an in-depth literature review of mobile application development (MAD) will be given. Firstly the history of MAD will be explained, after which MAD will be explained with some definitions on MAD. The different operating systems for mobile applications will be discussed followed by a software platform comparison together with mobile application characteristics. A discussion of challenges faced during MAD will be given after which a comparison of the PMMs with MAD characteristics will be combined. A table with these characteristics as a scoring unit for the various PMMs will be constructed to conclude this chapter.

3.1 MAD

In this section MAD will be described by referring to the history of mobile devices, mobile application development (MAD), operating systems of mobile applications and challenges faced during MAD.

3.1.1 History of mobile devices

The first mobile phones, First Generation, were developed by the handset manufacturers (Clark, 2012). It indeed was the first phone (network) with automated handover capabilities, thus what we perceive today as a standard for a mobile phone. Variants of mobile phones were in use long before this. Most notable the AT&T mobile radio system that integrated in the telephony network, as well the so-called A-Netz and B-Netz services (Gruber, 2005:17). Because of this new found industry, manufacturers found themselves in the competitive circle and had to guard their trade secrets closely. Manufacturers did not want their secrets to be exposed and did not want to outsource phone software development therefore they decided to develop in-house software. It was at this time that the first games on a mobile phone, such as Nokia's 1970's snake game, made their appearance. When the company realised that this was very popular, Nokia quickly started to add more games to their mobile phones, such as Pong, Tic-Tac-Toe and Tetris (Clark, 2012).

During this era people viewed the world of communication from a very different perspective. The demand for better and more phones increased, mobile phone

prices dropped, battery life time improved and the areas of reception started to expand rapidly. As with any development of a product it has to evolve and not stagnate. Customers started to demand more applications, but manufacturers could not keep up with the demand that every customer made. Therefore they came up with a better way to provide customers with these applications, the Internet (Clark, 2012).

Figure 3-1 below gives an overview of the developing history of the mobile application operating systems from 1995 to 2012 (Renner, n.d.):

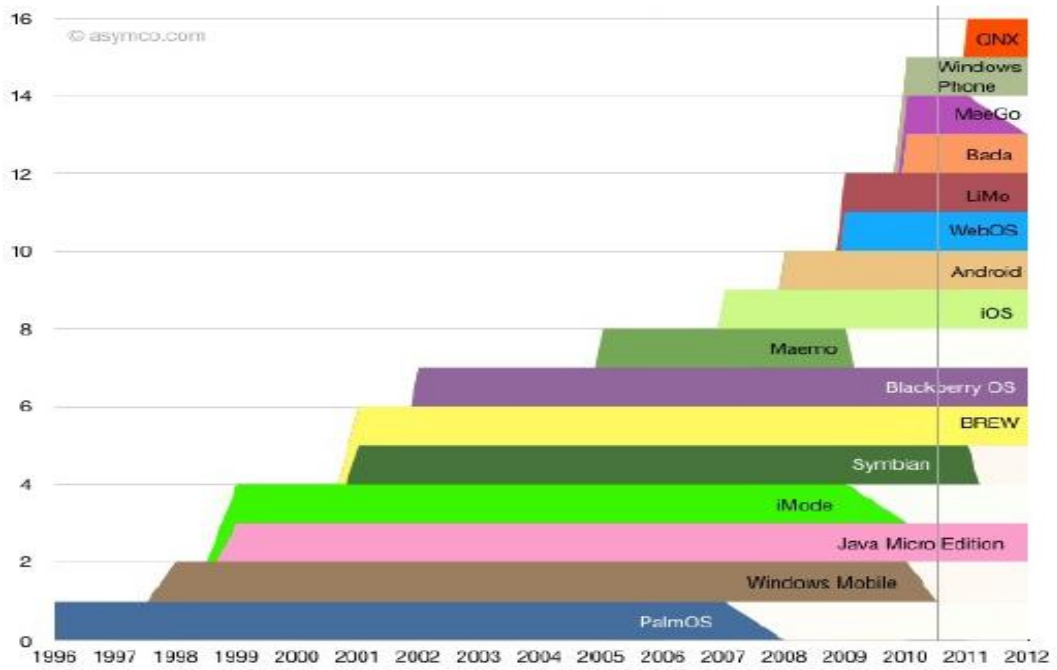


Figure 3.1 History of MAD (Renner, n.d.)

It all started with a device, called a mobile phone. This first working mobile phone was launched on 3 April 1973 in New York City by the mobile company, Motorola (Anon, 2013). Software products became extremely popular in the world, because of the richness that the applications bring to the environment (Carrol *et al*., 2013:19).

Mobile applications have become part of everyday life, from finding restaurants to helping to avoid traffic. The recent statistics show that the number of users using mobile/tablet applications was almost 1 800 million at the beginning of 2015 (Bosomworth, 2015). The Google Play store that provides applications for all android platforms has the biggest apps market (Ranger, 2015).

3.1.2 Mobile application development

Software development for mobile platforms has become one of the leading development environments today (Bosomworth, 2015). Mobile phones always had a closed environment until recently when software development now has an open platform for technology and anyone with the right set of skills can develop an application for mobile user (Abrahamsson *et al.,* 2004:174). Each of the developing products must be of high quality in order to function on various mobile phones. To gain the competitive edge in the development industry, you have to develop a better application than your competitors and release it up to one week before they do.

A software application only needs be created if (Carrol *et al*., 2013:19):

- There are demands for high availability
- The performance is efficient
- There is a short response time to the end user.

Janssen (2014) describes/defines Mobile Application as the following:

"a mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps are generally small, individual software units with limited function. This use of software has been popularized by Apple Inc. and its App Store, which sells thousands of applications for the iPhone, iPad and iPod Touch. A mobile application also may be known as an app, Web app, online app, iPhone app or smartphone app."

Wasserman (2010:2) defines Software Engineering as:

"a process by which an individual or team organizes and manages the creation of a software-intensive system, from concept through one or more formal releases."

He goes on by explaining that software engineering for embedded applications is, in all respects, similar to mobile applications. Wasserman (2010:2) further goes on by explaining that compared to traditional software development mobile application imposes additional demands, which are:

Application Interaction with other apps: Embedded devices already have software that is installed on them, whereas mobile devices have many apps that can perform on various platforms (Wasserman, 2010:2).

Sensor Handling: Today's advanced technology devices have touch screens that respond to certain gestures, virtual keyboards, GPS's, phone calls that work with an integrated camera, etc. (Wasserman, 2010:2).

Native and Hybrid applications: Embedded devices have software that is already installed, but mobile devices use the telephone and the Internet that displays data on the mobile device (Wasserman, 2010:2).

Families of Hardware and Software platforms: Code that is custom-built to perform certain properties is developed for embedded devices. Mobile devices have support applications that support all the different devices that are supported in the specific operating systems (which will be explained later) (Fring, 2009:164; Wasserman, 2010:2).

Security: Embedded devices do not have a direct way to be attacked by means of software, which can be defined as "closed" software, whereas mobile devices are more "open" to software attacks through the transmission of local data (Wasserman, 2010:2).

User Interfaces: With regard to embedded devices the "developer can control the user experience" (Wasserman, 2010:2). With reference to the mobile application all the elements concerning the user interface must adhere to externally developed user interface rules. These rules that must be followed are already implemented in the SDK (Software Development Kits) tools, which form part of the platform (Wasserman, 2010:2).

Complexity of Testing: Embedded device software is tested on the pc-based emulator, but the mobile applications are challenging when it comes to testing, because of the complexity of the transmissions that have to go through gateways and telephone networks (Wasserman, 2010:2).

Power Consumption: Dedicated, embedded devices can be changed to suit the environment where they are needed to the power source, whereas mobile

applications my inadvertently require extensive use of battery draining resources (Wasserman, 2010:2).

In the next part of this chapter the different mobile operating systems will be discussed with a characteristic comparison after.

3.1.3 Operating Systems for Mobile Applications

The result of a study on the market share of smartphone operating systems, released in May 2015 by a Company called NetMarketShare, is shown in Figure 3-2 (Anon, 2015a).

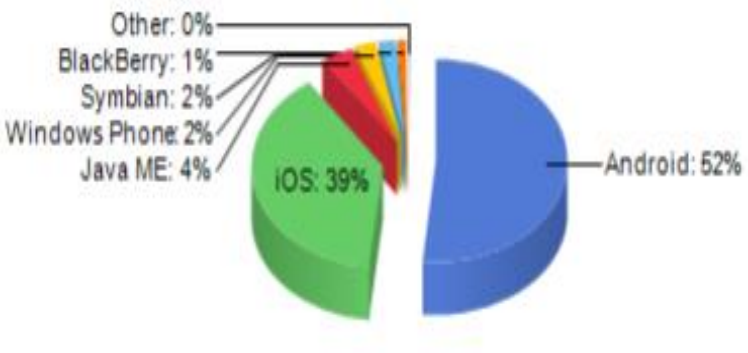


Figure 3-2 Mobile platform usages (Anon, 2015a)

The three leading software operating system companies, as stated above, are Android, Apple (iOS) and Java ME. These and some of the other platforms will be discussed.

3.1.3.1 Nokia (Symbian)

Symbian is an open-source operating system that was founded in 1998 by the mobile companies Nokia, Ericsson, Psion and Motorola. Nokia was the only company that acquired all the remaining shares of Symbian (Lin & Ye, 2009:618; Anon, 2012a). Symbian has many key features that consist of performance (designed to make minimal demands), multitasking (apps are designed to word seamlessly in parallel), software is object-orientated architecture, memory management optimized (embedded software), security (for safe data storage), etc. (Anon, 2012a).

3.1.3.2 Microsoft (Windows Mobile)

Windows Mobile was created by Microsoft who also developed the first operating system for personal computers. Windows Mobile uses tools and technology for station-based application development. Station-based application development is also similar to the environment of Visual Studio and frameworks of XNA, .NET Compact and Silverlight. Sandboxing for Windows Mobile uses the same model as Android and iOS. Just as iOS applications need to be signed, the third party applications of Windows Mobile need the same signature (Renner, n.d.).

3.1.3.3 RIM (BlackBerry OS)

Research in Motion (RIM) was founded by the University of Waterloo engineering students, Mike Lazardis and Douglas Fregin, also an engineering student in 1984. Throughout the years RIM expanded to become the first wireless data technology developer in North America. It also had developed other features, such as Film KeyKode Reader, Mobitext protocol converter, Mobitext X.25 gateway etc. In 1999 RIM introduced Blackberry solutions and software (Anon, 2012b). RIM was initially developed for business purposes (Anon, 2012b; Renner, n.d.). Blackberry OS also uses sandboxing, but it uses an older model for developing applications. What makes it so different from Android sandboxing is that Blackberry OS assigns the roles differently, which gives full access for applications to the device and the data (Renner, n.d.).

3.1.3.4 Apple (iOS)

Apple's operating system can only run on Apple devices, such as iPhone, iPod and iPad. The system architecture consists of Core OS (Kernel), Core Services (Fundamental system services, which have the framework of C and Objective C), Media (Graphic-, Audio- and Video technology) and Coca Touch (UIKIT, which provides the functionalities of the system framework). The basis of iOS's sandboxing is similar to that of Android (Anon, 2014a; Renner, n.d.). To ensure that an application is not tampered with or manipulated, every application must have a signed issue certificate (Renner, n.d.).

3.1.3.5 Google (Android)

Android is an open-source operating system for mobile devices that was designed and developed by Google (Renner n.d.). The system architecture consists of a Kernel, Libraries (C and C++), Application Framework, Runtime and Applications. Android uses sandboxing, which means that the code that is executed is inside a restricted area. The upside to sandboxing is that it ensures security policies and the execution of the applications. The following table (3-1) represents the software mobile platforms and the information to the applicable platform, created by Pratt (2009):

Table 3-1 Mobile software platforms and characteristics comparison

Mobile Software Platforms	Android	iPhone	Symbian	Blackberry	Windows Mobile 6 Pro
Company	Google	Apple	Nokia	RIM	Microsoft
Framework	Android	Cocoa	Symbian	n/a	.NET Framework
Operating System	Linux	iPhone OS	Symbian OS	Blackberry OS	Windows Mobile 6 Pro
Programming Language	Java, uses partly C++ Library	Objective C C/C++	Java C++	Java	C++ C#/VBA
IDE (Integrated Development Environment	Eclipse	XCode	Nokia Carbide C++ Express	Blackberry JDE Eclipse and VS tool is free	Visual Tools v4 Visual Studio
Signing Required?	No	Yes	No	Sometimes	No

Each platform is unique to its own environment as seen in Table 3-1. It is clear that there are great differences between these platforms which makes MAD very complex.

3.1.4 Challenges faced during MAD

The development of various applications to feature on multiple platforms and mobile devices can become somewhat challenging. Mobile application faces challenges, such as

- Network technologies (Hayes, 2002:232; Hall & Anderson, 2009:67)
    - This concerns the type of network the applications can run and whether they need network access or not. Some use network technologies, such as location-based technologies to determine their current location, where a certain point-of-interest is etc. The time it takes to download updates or other data is also a challenge.
- Performance and Efficiency on a variety of different platforms (Hall & Anderson, 2009:67)
    - Not all devices have touchscreens and therefore the applications need to perform just as well as on all other platforms.
- Specific needs of mobile users (Hayes, 2002:341)
    - Does the application cater for a terminal (a user that constantly sends and receives data over multiple networks (telecommunication))? Does the applicable application have all the functions and actions to perform for a terminal?
- Power Consumption (Thompson *et al.,* 2009:2)
    - Every action that is taken consumes an unknown quantity of battery power and thus for every line of code that needs to be executed this also consumes power. The number of lines with the number of instructions for an action to take place needs to be taken into account.
- Cross Platform Compatibility (Cheng & Yuan, 2005:765)
    - This concerns how compatible the application is to perform on different platforms (operating systems) and devices.
- Integration with device hardware (Wasserman, 2010:2)
    - The main concern here is whether the software and other components work well with the device hardware. Can the hardware support the application software components?
- Traditional Issues: Security, Reliability, Storage limitations and Performance. (Wasserman, 2010:2)

    - The common issues arise with regard to any application. Does the application protect the user data? Is there enough space for the application and the data that needs to be stored? Is the performance good enough for the particular user (beginner, intermediate or advanced)?
- Software Quality (Spriestersbach & Springer, 2004:11)
    - To ensure that the software is of a certain standard so that future problems and errors do not arise in the application. If the software standard is of low quality it is more likely that the application will consist of more errors and a greater chance of malfunction.
- Determining the purpose of the application and value to the user (Anon, 2004; Wasserman, 2010:2)
    - The application has to have a clear set of defined functions it must do. In other words what the application is intended for and what not. Each action on the device must have a clear purpose to the application and the user must know what to do with each action. How does the application suit the every-day life of the user?
- Lack of Applications (Hall & Anderson, 2009:67)
    - This concerns the number of applications that can be developed. Android is a true operating system where anyone can develop an application and deploy it on a device, whereas Apple applications need to be approved by Apple before being deployed to users.
- Start-up Time (Anon, 2004)
    - This concerns the time used for the application to start up. Mobile applications have short sessions and for a small session a shorter start-up time is appropriate.
- Responsiveness (Anon, 2004)
    - Mobile applications should have a fast response time otherwise users will become impatient. If something does not work you try again and again. This leaves the problem with unwanted tapping or interaction with the application causing error or malfunction.
- User experience (Huisman *et al.*, 2012)

    - How well the user interacts with the application and what the user's impression is of the application. How well is the learnability of the application to any user? Should there first be training involved or would it be easy enough for any user.
- Accurately predicating battery consumption of arbitrary architectural decisions is difficult (Thompson *et al.*, 2009:2)
- Effects of transmission medium on power consumed are largely device application and environment specific (Thompson *et al.*, 2009:2)
- It is problematic to accurately predict the effects of reducing sensor data consumption rates on power utilization (Thompson *et al.*, 2009:2)
- Accurately assessing effects of different communication protocols on performance is difficult without real-world analysis (Thompson *et al.*, 2009:2)

It is clear that there are various challenges faced when it comes to MAD development. No challenge is more important than the other. These challenges will be used as characteristics to combine with the previous mentioned PMMs. The characteristics will be scored to the corresponding PMM.

3.2 Combining PMM with MAD characteristics

Research regarding each of the PMM types was followed with further research on combining PMM with MAD characteristics. In Table 3-2 can be seen if and how each of the PMMs caters to a specific mobile application characteristic.

As mentioned above, each PMM was investigated by studying the most important sources of each PMM type, by taking each characteristic one at a time and readying the materials of each PMM to ascertain how the PMM caters to that specific characteristic. Thereafter a score was given for each based on a scale from 0 to 10, ranging from 0, showing no interest in the specific characteristic, to 10, showing intense focus on the specific characteristic and finally adding all the scores in the end to give each PMM a total for all the characteristics. The characteristics used to aid in the evaluation were found in the sources mentioned and explained in the previous section.

Table 3-2 Combining PMM with MAD characteristics

Characteristic	Agile	PRINCE2	PMBOK	COBIT
Variety of Platforms				
Network technologies	0	0	0	3
Cross Platform Compatibility	2	0	0	3
Performance and efficiency	8	7	8	7
Power Consumption	0	0	0	0
Traditional Issues				
Security	4	0	6	6
Reliability	6	0	5	8
Storage limitations and Performance	3	0	3	6
Integration with device hardware	4	1	6	7
Software Quality	7	9	9	8
User Experience	2	2	2	2
Specific needs of mobile users	0	0	2	0
Determining the purpose of the application and value to the user	6	9	5	5
Start-up Time	0	0	0	0
Responsiveness	0	0	0	3
Lack of Applications	0	0	0	0
Total:	**46**	**27**	**47**	**53**

3.2.1 Scoring Description

The scoring of these characteristics in each of the PPM's is based on the resources provided earlier in each PMM's description as set out in Chapter 2.

Variety of Platforms

Network technologies: Agile, PRINCE2 and PMBOK all scored a 0, because none of these methodologies caters in any way for networking technologies.

COBIT scored a low 3, because COBIT looks at networking in general and not in depth on lower phases and activities. That is the reason for the score of 3.

Cross Platform Compatibility: In general all PMMs cater only for systems/projects as a whole and not specific types, thus PRINCE2 and PMBOK scored a 0 in this case. As Agile, when considering the project, caters for compatibility in a manner, it scores 2. COBIT, on the other hand, when also considering that this is a large scale PMM, caters to some extent for platform technologies and compatibility, scores a 3 for this challenge.

Performs and Efficiency: Both Agile and PMBOK scored an 8 for this characteristic, because they are more focused on the efficiency and the performance of the applied projects than PRINCE2 and COBIT who scored a 7 in this matter. One can see that for all these methodologies performance and efficiency are a priority.

Power Consumption: All four of these methodologies, Agile, PRINCE2, PMBOK and COBIT, scored a 0, because none of them even looks at the possibility of power consumption. Power Consumption can fall under one of their other categories or technologies, but as described, none of them looks at the matter concerning power consumption.

Traditional Issues

Security: Both PMBOK and COBIT address the issue of information security in certain aspects of the methodology and not in all of them. That is why a 6 was awarded. Agile got a 4 for looking at security, but not to the same extent as PMBOK and COBIT. PRINCE2 scored a 0 on the security measure, because PRINCE2 does not cater for security.

Reliability: COBIT scored an 8 in this characteristic, because in the COBIT cube, reliability is one of the main business requirements that must be met and therefore it

caters for this aspect. Agile scored a 6 and PMBOK scored a 5 as Agile focuses more than PMBOK on reliability, but not in a substantial manner. Again PRINCE2 scored a 0, because of the lack of concern for liability.

Storage limitations and Performance: COBIT is more concerned with the storage of resources, etc., but not as much with performance, which is why a 6 was awarded. Both Agile and PMBOK scored a 3, because they do not cater to this characteristic as COBIT does; only in respect of a few aspects. PRINCE2 scored a 0, because it does not mention storage or performance.

Integration with device hardware: COBIT again scored the highest in this category with a 7. COBIT strongly addresses integration in more than one aspect in quality management, integration metrics, etc. PMBOK scored the second highest with a 6, because of a dedicated life cycle towards integration. The reason for the 6 is because PMBOK's integration can contribute to this aspect in general, which can include device hardware if it chooses. Agile scored a 4 because it does not address the characteristic as PMBOK does. PRINCE2 scored a 1 as this methodology only mentions integration minimally.

Software quality: Here both PMBOK and PRINCE2 scored a 9 because they concentrate on high quality software. Spriestersbach and Springer (2004) stated that software needs to be of a high quality to meet the requirements. COBIT scored an 8 because it has a phase dedicated to quality management. Agile scored 7, because of the extent to which it is dedicated to quality, but not to the same extent as the other methodologies.

User experience: Agile, PRINCE2, PMBOK and COBIT all scored a 2 in this regard because they cater in a very small way for the user and user involvement in the process. Not much has been added in the literature in respect of the experience of the user.

Specific needs of mobile users: PMBOK scored a 2 in this regard because they cater to a very small extent for the needs of the terminal users. Agile, PRINCE2 and COBIT scored a 0, because of no involvement in respect of this characteristic.

Determining the purpose of the application and value to the user: PRINCE2 scored a 9 for this characteristic as it caters to a considerable extent for the value of the application/software to the end user. Agile scored an above average 6 for user value

in the development process. PMBOK and COBIT scored 5 because they only cater to an average extent for the user and the value that it has.

Start-up Time: All these methodologies, Agile, PRINCE2, PMBOK and COBIT, in no way mention this characteristic in the management process. Thus they scored 0.

Responsiveness: This characteristic is only addressed by COBIT who scored a 3. Only this methodology caters for the responsiveness of the software and user involvement. The other three methodologies are not concerned with this aspect.

Lack of Applications: None of the methodologies caters for or mentions a lack of applications.

It is clear form Table 3-2 COBIT had the highest scoring of all the PMMs. Second was PMBOK then Agile and lastly PRINCE2. It can be seen those characteristics such as: Power consumption; Start-up time and Lack of applications were never addressed in the literature of these PMMs. It is clear that there is no suitable PMM of all these major MAD characteristics.

A literature review of mobile application development was given. The history of MAD was given with different types of platform that exist. At the conclusion of the chapter certain characteristics from literature that are important to MAD were highlighted. A table with these characteristics was presented as a scoring unit for the various PMMs. The next chapter will include the research design used in this study.

CHAPTER 4
RESEARCH DESIGN

In this chapter, the research design will be discussed. A mixed methods design will be used for this study, which is a combination of the positivistic and interpretive paradigms. There are four mixed methods approaches, namely (Creswell & Clark, 2006:62-75):

- **The Triangulation Design**: The purpose of this design is “to obtain different complementary data on the same topic”.
- **The Embedded Design**: Where one dataset provides a supportive, secondary role in a particular study that is based on the other data type.
- **The Explanatory Design**: This a two-phased method in which the purpose is that the qualitative data helps explain the initial quantitative results.
- **The Exploratory Design**: Also a two-phased method in which the results of the qualitative data can help the quantitative data.

This study will use the explanatory design. Firstly, the positivistic and the interpretive paradigms will be discussed with each paradigm’s data generation and data analysis techniques and how they were used in this study. Secondly, the concept of a mixed methods approach will be discussed and how it will combine both these paradigms. A mixed methods approach is used, which includes the combination of qualitative and quantitative methods in order to provide a better understanding of the research problem. Applying the mixed methods design (QUAN→qual) consists of first collecting the quantitative data, which is then followed by the collection of the qualitative data (Creswell, 2012:538). The qualitative data helped to explain the quantitative results.

4.1 Research aims and objectives

The main aim of this study is to research the use and effectiveness of project management methodologies in mobile application development. In order to achieve this aim the following objectives will be addressed:

1. Determine the current status of mobile application development in South Africa
    - The quantitative methods will be used to achieve this objective.
2. Determine the success of mobile application development in South Africa
    - The quantitative method will be used to achieve this objective.
3. Determine the use of project management methodologies (if any) in mobile application development.
    - The quantitative method will be used to achieve this objective.
4. If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used[1].
    - The quantitative and qualitative methods will be used to achieve this objective.
5. If project management methodologies are used, determine how intensely, widely and strictly they are used.
    - The quantitative method will be used to achieve this objective.
6. If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen[2].
    - The quantitative and qualitative methods will be used to achieve this objective.
7. If project management methodologies are used, how effectively are they used?
    - The quantitative method will be used to achieve this objective.

All the above-mentioned objectives will be met by using the mixed methods approach. Each of the above-mentioned objectives has an indicator below indicating which research method will be used.

[1] The highlighted sections are the qualitative methods of this study
[2] The highlighted sections are the qualitative methods of this study

4.2 Research Paradigm

Oates (2006:282) stated that a paradigm is a "*set of shared assumptions or ways of thinking about some aspect of the world*".

In this section the mixed methods approach and the positivistic and interpretivistic research paradigms will be discussed. Each will be defined and an explanation of how they were allied in this study will be given.

4.3 Mixed Methods

4.3.1 Definition

This study consists of a mixed method that includes both qualitative and quantitative research. De Vos (2011) defines a mixed methodology as:

"*Mixed methods research refers to a separate methodology in which both qualitative and quantitative approaches, methods and procedures are combined or "mixed" to come up with a more complete picture of the research problem*."

According to Creswell and Clark (2006:6-9), there are major elements that play a role in mixed methods research, namely:

- Mixed methods research consists of both quantitative and qualitative data which means that the researcher collects both text information and numerical information.
- This method can be used in a single study or multiple studies in a program of inquiry.
- Mixed methods research is a unique way of doing research, in other words that in some cases doing only quantitative or qualitative research is just not enough. Data needs to be mixed to form a clearer picture of the problem than they do standing alone.
- Mixed methods research enables the researcher to address a range of exploratory and confirmatory questions at the same time.
- Mixed methods research provides more evidence for studying a research problem than either qualitative or quantitative research alone.

- A mixed methods study eliminates a variety of bias, explains the true nature of a phenomenon under investigation and improves various forms of validity or quality criteria.
- Mixed methods research encourages researchers to collaborate across the relationship between quantitative and qualitative research.
- Mixed methods research offers the opportunity for a bigger assortment of divergent views and perspectives. It also makes the researcher more alert to the possibility that issues are more multifaceted than they appear.
- Mixed methods research promotes the use of multiple worldviews or paradigms instead of the typical association of certain paradigms for quantitative and qualitative research.

As previously mentioned, this study will focus on the explanatory design of mixed methods. The following are important when using the mixed methods design:

4.3.1.1 Design

As previously mentioned, explanatory design is a two-phased mixed method. Firstly, there is the gathering of the data and then the analysis of the quantitative data. Then there is the collection of the qualitative data. It is so designed that the qualitative phase follows/connects to the results of the quantitative phase (Creswell & Clark, 2006:72).

4.3.1.2 Strengths

There are various strengths when using explanatory design, namely (Creswell & Clark, 2006):

- The two-phased method is a straightforward implementation, because of the two separate collections of the data, each on its own schedule.
- It makes it easier to provide clear delineation for readers.
- It is a multiphase investigation.

In the mixed methods approach the quantitative data was gathered through the positivistic paradigm and the qualitative data was gathered through the interpretive paradigm. Each of these paradigms will be discussed next to show how they were used in this study.

4.4 Positivism

The positivistic paradigm underlines the scientific methods used. The term was designated as the philosophy of Auguste Comte, who held that human thought had passed inevitably through a theological stage into a metaphysical stage and was passing into a positive, or scientific stage.

4.4.1 Research method

A survey was used to gather the quantitative data to study its influence on the research question. The reason why a survey was used on the mobile developers is, because it covers a large amount of data to be captured from a large groups of people.

4.4.1.1 Data requirements

Questions in the survey are paired with the aims and objectives of this study:

Table 4-1 Questions to project aims and objectives

Determine the current status of mobile application development in South-Africa.	Do you develop mobile application software? • Yes/No
Determine the success of mobile application development in South Africa.	**Outcome of the project:** Which of the following best describes the outcome of the last mobile application development project you were involved with? • The project was cancelled/terminated before completion • The project was completed but not implemented • The project was completed and implemented, but not in use anymore • The project was completed and implemented, and is in use Participants needed to choose one of the above mentioned statements to determine the outcome of the project. **Success of the process:** • The project was completed on schedule • The project was completed within the

	budget • The development system satisfied all the stated requirements • The speed of developing the project was high • The productivity of developers involved with the project was high • The cost of the project is low when compared to the size and complexity of the system developed • The project achieved its goals • Overall, the project represents excellent work • Overall, the project was a success The participants needed to score the above mentioned statements on a Likert scale from 1 to 5 (where 1 = Totally Disagree and 5 = Totally Agree) **Success of the product:** • The functionality of the development is high • The reliability of the development is high • The maintainability of the development was high • The portability of the development is high • The efficiency of the development is high • The usability of the development is high • The development system meets user needs • The documentation of the development system is good • Overall the quality of the development system is high • Overall, the users are satisfied with the development system • Overall, the development system is a success The participants needed to score the above mentioned statements on a Likert scale from 1 to 5 (where 1 = Totally Disagree and 5 = Totally Agree)

Determine the use of project management methodologies (if any) in mobile application development.	Do you use a project management methodology? • Yes/No How many project management methodologies do you use? • 1 • 2 • 3 What project management methodologies do you use? • Agile • PMBOK • PRINCE2 • COBIT
If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.	Why don't you use a methodology? • Open question to the participants Have you ever considered using a methodology? • Yes/No Determine how project control and management of the project take place • We always complete a project plan for our projects • All our projects use product-based planning technique • We determine our projects' justification and scope • All our projects follow an effective project initiation or start-up stage • We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations • It is important to make project communication transparent at all levels • All our projects have a phase where we build the physical project deliverables and present them to our customers for sign-off. • We have sometimes resolved management, operational and technical issues during the course of projects • All our projects follow a calendar of core project plan with intended start and finish dates • All our projects have defined project

	management roles • All our projects follow effective cost management • Our Clients, Suppliers and Users of the projects are organized and coordinated so that the required outcome is within budget, on time and to specification • A project support office is set up to assist project managers with their work like administrative work needed, keeping files and arranging meetings especially during large projects • Effective project procurement management is an important process • All our projects have a clear focus on where to prioritize and place project resources • We often use the same project management method for similar projects • We understand the background or history of the projects we undertake • We estimate the time, money and people we need for the job We hold regular meetings with our clients • We carry out a project closure process after completion • Our project approach requires decision making and phasing in managing the project • The scale of the projects influences the methodology to be used • Our methodology removes the causes of failure in our projects • The use of methodologies influences the entire project life cycle from conception to project closure • The current economic downturn has affected our use of project methodologies The participants needed to score the above mentioned statements on a Likert scale from 1 to 5 (where 1 = Totally Disagree and 5 = Totally Agree) Reasons for not using a PMM • The profile of development projects in our IS department doesn't require the use of project management methodologies • Project management methodologies

	are too complex or hard to use • The current project management practice in our IS department is adequate • The experience of the system developers in our IS department reduces the need for project management methodologies • The benefits of project management methodologies use are long term, whereas costs are incurred short term • There is a lack of experienced staff in our IS department who can effectively use project management methodologies • New system development with project management methodologies are not compatible with legacy systems • Our IS department lacks a suitable environment to support project management methodologies • In our IS department there is a lack of management support for the use of project management methodologies • The learning curve of project management methodologies is very long • The financial investment in project management methodologies is too long • In our IS department there is a lot of uncertainty over the benefits of adopting project management methodologies • In our IS department there are no clear objectives for adopting project management methodologies The participants needed to score the above-mentioned statements on a Likert scale from 1 to 5 (where 1 = Totally Disagree and 5 = Totally Agree)
If project management methodologies are used, determine how intensely, widely and strictly they are used.	How intense do you use the project management methodology? • Scale from 1 to 10 (where 1 being not intensely at all and 10 being very) How widely do you use the project

	management methodology in the project? (# of people in the company) • Scale from 1 to 10 (where 1 being not widely at all and 10 being very) How strictly are you regarding the use of the project management methodology? • Scale from 1 to 10 (where 1 being not strictly at all and 10 being very)
If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.	Activities provided and the participant needed to score on a Likert scale from 1 to 5. Why did you choose the particular project management methodology? • Open question to the participants
If project management methodologies are used, how effectively are they used?	Obtained from statistical data from the methods that have been given in the beginning of this study and will be later mentioned again.

These questions address the topics in the research question. Additional questions include demographics and other factors that might influence the use of PMM and MAD (for example the government of the country).

4.4.2 Data generation method

There are a couple of methods that can be used, namely questionnaires, theorem proof, structured interviews, field experiments, laboratory experiments, simulation, comparative and observational studies. In this study a questionnaire has been chosen for the data collection. This method was chosen because it is the best way to capture all the different aspects of data that needs to be gathered. This questionnaire is electronic as the postage service in South Africa is not such that it is conducive for research. This electronic questionnaire was sent out to people who develop mobile software in South Africa. There are various reasons for choosing an electronic survey:

- It limits the mistakes made compared to that on paper and paper is saved (De Vos, 2011).
- Faster and inexpensive (Oates, 2006:102)

- Removing the possibility of human errors (Oates, 2006:102)
- Makes it easier to analyse (Oates, 2006:193)

4.4.2.1 Sampling frame

The sample frame consists of project managers and mobile developers as the participants. The questionnaire was sent out to people who and companies that develop mobile application software in South Africa. The people and companies were identified firstly, according to who develops mobile applications, and secondly, who do use project management methodologies. People and companies were identified through an extensive internet search. The sample size was a usable 166 responses. The background information of the participants that were captured during the survey is depicted in Table 4-2:

Table 4-2 User profile of the participants

Individual	Business	Project
Age	Business area	Description
Gender	Company size	Size
Race	Target audience	Platform
Job Title	Developing MAD (yes/no)	Budget
Experience	% of MAD development	Project member involved
Qualifications	Markets operated in	

4.4.2.2 Sampling technique

As the survey was electronic, the convenience sampling technique was appropriate as it only includes those with access to the internet.

4.4.2.3 Response rate

Oates (2006) states that it is common to get only a 10% response rate for electronic questionnaires. The questionnaire was sent to companies that develop mobile applications in South Africa. The completion of the survey was voluntary, and therefore it cannot be established who completed the survey. The questionnaire was

electronic and was constructed on Google Forms. The number of questionnaires that was distributed is as follows:

- Companies: 244
- Individual emails: 1 345
- Groups and Forums: 15 (where the average number of users was about 1 361)

The response rate was ± 10%. It is very difficult to calculate the response rate, but when assuming for each company, individual and groups and forums received 1 questionnaire. In total 1 604 emails was sent and resulted in the 166 usable questionnaires. Because this was an electronic questionnaire one could not determine which questionnaire came from which individual, because the questionnaire was anonymous. The corresponding groups and forums were only selected on the grounds of being applicable within the South African community and who develop mobile applications.

4.4.2.4 Form of administration

The questionnaire was self-administered as the respondents would complete the questionnaire on their own.

4.4.2.5 Question content and wording

The following guidelines were used for the wording of the questions (Oates, 2006:221; De Vos *et al.,* 2012:192):

- Brief – none of the questions was longer than 20 words. All questions were understandable.
- Relevant – all questions were relevant to the study, as well as to the research objectives.
- Unambiguous – clear words and wording was used to not confuse the participant.
- Language – Questions were formulated in the language that most respondents understand, namely English.

The following guidelines were kept in mind regarding the questions (De Vos *et al.,* 2012:192):

- Try not to lead the questions.
- Avoid biased questions.
- Contemplate the length of the questions; rather keep them short.
- Do not use slang, jargon and abbreviations.
- Categorize the questions to suit the response.

4.4.2.6 Question types

Quantitative data will be collected, which calls for only closed questions. This lets the participants choose an answer from a range of predefined answers chosen by the researcher. These answers will be based on the literature study on the topic, making it more relevant to the research topic.

4.4.2.7 Format of questions and responses

The following types of question were used in the questionnaire with some examples. See Annexure A for the full questionnaire:

- Yes/No
    - Do you develop mobile application software?
    - Do you use a project management methodology?
- Quantities
    - What is the size of the company?
        - 10-20
        - 20-30
        - 30-40
        - 40-50
        - 50-60
        - 60-70
        - 70-80
        - 80-90
        - 100+
- Likert scale (From 1 to 5, where 1 is “Totally disagree” and 5 “Totally Agree”)
    - The project was completed on schedule
    - The project was completed within the budget
    - The speed of developing the project was high
- Listing

    - Who is your target audience?
        - Business
        - Individual
        - Enterprise
- Describing
    - Describe the last project on which you have worked
- Open questions
    - Why did you choose the particular project management methodology?
    - Have you ever considered a project management methodology?

According to Grinnell and Unrau (2008:288), one should insert a covering letter in the beginning to introduce the study in a credible manner. The letter should also be personalized and interesting to the participant.

It is important to do a pilot study of the questionnaire before it is released. The pilot study will help to determine if there are any errors in the questionnaire and then to rectify them (De Vos *et al.,* 2012:195). The questionnaire was sent out to participants who had knowledge of mobile application development and project management methodologies for the pilot study. This helped to

- find difficulties in answering the questions
- discover ambiguous or vague questions
- determine whether there is confusion between the type of question and instructions and questions
- determine the average time for answering all the questions.

4.4.2.8 Validity and reliability

The researcher considered the following guidelines (Oates, 2006; De Vos *et al.,* 2012:174):

- Content validity where all the questions covered by the research question.
- Construct validity where it was considered if the questions are measuring the things the researcher wishes to measure through the questionnaire. This is accomplished through pilot testing.
- Reliability (refers to the dependability, consistency, trustworthiness, stability and faithfulness) where the questionnaire will give the same results when repeated again.

- Neuman and Kreuger (2003:179-180) and also Salkind (2006:108) recommend the following procedures to increase the reliability of measurements:
  - Use multiple indicators of a variable – Use two or more indicators to measure the aspect of the variable.
  - Eliminate items that are unclear – Items that are unclear result in unreliability.
  - Increase the level of measurement – Measurements are more likely to be reliable if the indicators are high. Try to measure the most precise level possible.
  - Use pre-tests, pilot studies and replications – Develop drafts of measurements before applying the final version.
  - Standardize instructions.
  - Maintain constant scoring procedures.
  - Statistical test: Reliability analysis and Cronbach alpha.

4.4.3 Data analysis method

For the questionnaire, descriptive statistics, factor analysis, reliability analysis and t-tests were used to analyse the collected data. Each of these techniques and how it fits into the study are discussed.

4.4.3.1 Descriptive Statistics

The descriptive statistics refer to describing the data that was gathered from all the participants. Descriptive statistics were used to determine the background of the respondents in the sample.

4.4.3.2 Factor Analysis

Factor analysis was used to reduce the data and to determine the reasons why PMMs are not used in their activities. The constructs for the dataset on the correlations between the questions were detected.

4.4.3.3 Reliability Analysis

Reliability analysis was done to ensure the consistency and stability of the results found in the questionnaire. For this study the Cronbach's Alpha was used to

determine these factors. The accepted factors for reliability are > 0.6 (Santos, 1999:3), therefore each of the factors greater than 0.6 will be used.

4.4.3.4 Effect sized and t-test

There are particular questions that have been evaluated according to the t-test. When looking at t-test values, 0.8 indicates a large effect, i.e. plainly evident, 0.5 indicates a medium effect, i.e. observable and 0.2 indicates a small effect, i.e. hardly visible (Ellis & Steyn, 2003). All the questions done on the t-test with an effect size of medium and greater will be used and discussed further. One will look at effect sizes so that a convenience sample can be used.

This concludes the discussion of the positivistic paradigm. In the next section the interpretive paradigm will be discussed with the corresponding research method, data collection method and data analysis techniques.

4.5 Interpretivism

"*Interpretive research in IS and computing is 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* " (Oates, 2006:292).

Interpretivism research tries to identify, explore and explain factors in a specific social setting, looking at how people perceive their own world and then trying to understand everything through meanings and values that people assign to them.

4.5.1 Aims and Objectives

In this section of the study, two of the aims and objectives will be met by the qualitative data. The two aims and objectives can be found in Table 4-3:

Table 4-3 How the aims and objective will be met by analysing qualitative data

Aims and objectives	
If no project management methodology is used, determine how control and management of projects take place; **understand the reasons why project management methodologies are not**	Open question for the participants

used.	
If project management methodologies are used, **understand the reasons why the specific project management methodology was chosen.**	Open question for the participants

4.5.2 Research method

Oates (2006:142) defined the following characteristics of interpretivism:

- Focus on depth rather than breadth – The researcher has to gather as much detail as possible applicable to the instance of investigation.
- Holistic study – The holistic study involves the complexity of relationships in the involved processes. The researcher tries to understand how they are interconnected rather than to isolate the individual factors.
- Natural setting – This is the occurrence in its natural setting; in other words the setting is artificial or in an experimental laboratory.
- Multiple sources and methods – There are a number of methods and data sources the researchers can use in their studies. In any case both quantitative and qualitative data can be used. Methods of data generation include (Oates, 2006):
    - Questionnaires (Standardized questions)
    - Interviews
    - Document Analysis
    - Observation
    - Field Notes.

The type of study will be an explanatory study as the research question is to determine if the use of PMM increases the effectiveness, and if so, why and how. This study will explain the outcomes that have been reached. This study may be the first of a series of studies that will investigate the use and effectiveness as PMMs that are applied together with MAD.

4.5.3 Data collection method

Interviews will be used as the data collection method for the qualitative data. The total number of interviews conducted was 49. The interviews in this study were semi-structured. The interviewer asked a set of questions to the interviewee and took notes as the interview progressed. This allowed all the interviewees to speak freely and the researcher had the opportunity to delve deeper into the answers the participants provided. This helped to understand what the project managers are experiencing in their own particular way.

The interview started with an introduction of the topic of the study, where-after the interview was conducted.

The researcher took into account what his/her role is going to be in the interviews. Some people responded differently according to how they perceive the person who is asking the questions. The researcher needs be professional at all times and must be polite, neutral to the answers, and punctual. Age, sex, status, ethnic origin all play a very critical role when conducting the interview and therefore the following components for the interview in general need to be taken into account:

- Age gap – There was a large age gap, as all the project managers are much older than the researcher. This, however, did not influence the interview as everyone acted professional.
- Considering the topic of the interview, there was no lack of willingness from the project managers from any ethnic group or gender.

The preparation for the interviews was recapped on the research done in the past regarding the concepts of PMM.

Interviews were scheduled with each respondent and not as a group. This led to fully understanding of the implications, and how they affected the effectiveness. Each interview was between one and one and a half hours. This was enough time to capture all the relevant data and aspects that each interviewee wanted to express on each question.

The interviews were held in the natural workplace (office) of each of the project managers. This resulted in the researcher sitting opposite the manager, or next to

the manager when they were seated in a room. In this case, a private office was used to allow the interviewee to speak freely.

The equipment used was a few pages to take notes. No other technology was used as this could place the interviewee under stress.

The interview was structured as follows:

- Introduction and welcome. The respondent was welcomed and thanked for being willing to be part of the study.
- The respondent was given an overview of the study, what the aim was and what was expected from the interview.
- The respondent was given the assurance that that the interview would be entirely anonymous and confidential.
- Introduction question to start the interview. The open questions included in the questionnaire were:
    - Describe the last project on which you worked.
    - Why did you choose the particular project management methodology? / Why don't you use a PMM methodology?
    - What types of project management tool do you use and why?
    - Have you ever considered using a PMM?
    - General Problems/Challenges you face with the projects.

4.5.4 Data analysis method

Content analysis was used as a data analysis method for the interviews conducted and the open questions in the questionnaire. According to Oates (2006:239), content analysis can be described as: "*a quantitative technique that counts the number of times something occurs in a set of documents*" or in this case, interview and open questions. Codes were designed for each of the "counts" and a description of these codes was given.

In this chapter, the research design was discussed. A mixed methods design was used for this study, which is a combination of the positivistic and interpretive paradigms. The chosen mixed method design, Explanatory design, was discussed. Both the positivistic and interpretive paradigm's research methods, data collection and data analysis techniques was discussed. The following chapter will consist of the results from the quantitative data of this study.

CHAPTER 5
QUANTITATIVE RESULTS

The purpose of the following two chapters is to report the results from the questionnaires and the interviews. The quantitative results (questionnaires) will be discussed in Chapter 5 and the qualitative results (interviews) will be discussed in Chapter 6. As previously mentioned, each of the questions is designed to meet an aim and objective of this study. The reported findings will consist of various data analysis methods: descriptive analysis, reliability analysis, factor analysis and t-tests. Each of these data analysis methods is assigned to each section of the questionnaire (as seen below). The questionnaire is divided into six sections:

- Individual: Questions concerning the background of the individual. This includes the age, gender, race, job title, experience and qualification obtained. Descriptive analysis will be used for this part of the questionnaire.
- Business: Questions concerning the background of the business. This includes the business-operated markets, company size, targeted audiences and whether or not they develop mobile applications or not. Descriptive analysis will be used for this part of the questionnaire.
- Project: Questions concerning the background of the last project on which they have worked. This includes the description of the last project on which they have worked, size of the project, platforms operated in, set budget and the number of people involved. Descriptive analysis will be used for this part of the questionnaire.
- Mobile application development: Questions related to the mobile application project they have worked on. This includes the measurement of the outcome of their projects, success of their processes and the success of their products. Descriptive analysis, factor analysis and reliability analysis will be used for this part of the questionnaire.
- Using project management methodologies: Questions related to determining the number of PMMs used, types of PMMs, reasons why PMM was chosen (which is an open question), how intensely, widely and strictly the PMMs are used and the PM activities they use. Descriptive analysis, factor analysis and

reliability analysis will be used for this part of the questionnaire. The open questions will be addressed in the next chapter.

- Not using a project management methodology: This question determines the reasons for non-use of project management methodology (this was also an open question), if they ever considered using a PMM, reasons for non-use on a Likert scale and the PM activities applied. Descriptive analysis, factor analysis and reliability analysis will be used for this part of the questionnaire. The open questions will be addressed in the next chapter.

5.1 Research aims and objectives

The main aim of this study is to research the use and effectiveness of project management methodologies in mobile application development. In order to achieve this aim the following objectives will be addressed:

1. Determine the current status of mobile application development in South Africa.
2. Determine the success of mobile application development in South Africa.
3. Determine the use of project management methodologies (if any) in mobile application development.
4. If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.
5. If project management methodologies are used, determine how intensely, widely and strictly they are used.
6. If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.
7. If project management methodologies are used, how effectively are they used?

5.2 Background information of the respondents that participated in the survey

In this section of the chapter the background of the individual, company and the projects the participants have worked on will be reported.

5.2.1 Background of the Individual

These questions asked for the individuals' age, race, gender and experience.

Firstly, looking at the data describing the individual, the ages ranged from the youngest, which was 19 years old to the oldest respondent, who was 53 years of age. The average age of all the participants was 29 years.

The gender distribution of all 166 respondents was 84% males and 16% females.

Table 5-1 Race of the participants in the sample

		Frequency	Percent	Valid Percent	Cumulative Percent
	Black	24	14.5	14.5	14.5
	White	120	72.3	72.7	87.3
	Asian	3	1.8	1.8	89.1
	Indian	13	7.8	7.9	97.0
	Other	5	3.0	3.0	100.0
	Total	165	99.4	100.0	

The options for the race distribution was Black, White, Asian, Indian and Other, where 14.5% were Black, 72.7% were White, 1.8% selected Asian, 7.9% selected Indian and Other was 3%.

Regarding the experience of the individual, a range of options in years, as seen in Table 5-1, was given to each of the participants. One can see that of all the participants, 5 and 10+ years of experience achieved the highest indication and 9 years was the lowest indication.

Table 5-2 Experience of the participants in terms of years

Experience in Years		Frequency	Percent	Valid Percent	Cumulative Percent
	1	11	6.6	6.6	6.6
	2	21	12.7	12.7	19.3
	3	24	14.5	14.5	33.7
	4	24	14.5	14.5	48.2
	5	26	15.7	15.7	63.9
	6	13	7.8	7.8	71.7
	7	10	6.0	6.0	77.7
	8	7	4.2	4.2	81.9

	9	4	2.4	2.4	84.3
	10+	26	15.7	15.7	100.0
	Total	166	100.0	100.0	

One can see that the majority of the participants are captured in the 1- to 5-year group of experience with 63.9% whereas the other 36.1% falls in the 6 to 10+ years of experience.

5.2.2 Qualifications of the participants

Table 5-3 Qualifications of the participants

Qualification	Count
B.Sc. Degree (IT/IS/CS/CE)	106
B.Sc. Honours (IT/IS/CS/CE)	55
Matric	119
Diploma IT related field	55
M.B.A.	4
PM Qualification (PRINCE2, PMBOK, PMI, PMP)	17
Master's degree (IT/IS/CS/CE)	8
Certification in programming	22
Training in an IT related field	33

This was an open question addressing the participant's qualifications. Each participant needed to give his/her top three qualifications, but they were not bound by this question. They could have given one, two or three qualifications. One can see that the majority, namely 116, has matric. Of the 116 one can see that 106 of the participants have a degree in Information Technology, Information Systems, Computer Science or Computer Engineering. Of those 106 participants only 55 have an honours degree in that same field whereas only eight have a Masters degree. Only four participants have done their MBA.

Out of all the participants 55 did a diploma in an IT-related field whereas only 22 did a certification in a type of programming. The other 33, as one can see in Table 5-3, underwent training in an IT-related field. Only 17 are certified project managers in either PRINCE2, PMBOK, PMI or PMP.

Looking at the complete profile of the individual, one can see that the majority of the participants are male. Regarding the race of the participants, one can see that the majority is white. The profile includes participants who have many years of experience in this particular field with high qualifications to their name.

This concludes the background of the individual. Next the background of the company will be given and discussed.

5.2.3 Background of the company

The questions regarding the company concentrated more on the aspects of the audience, size, markets, etc.

The first question addressed the markets in which the particular company operates. There were six options that were given, namely IT, Banking, Agriculture, Education, Manufacturing and Insurance. IT was the highest of the markets with 83.7%. Banking was the second highest with Insurance not far behind. Manufacturing was chosen by 31.9% of the respondents and Education by 23.5%. Agriculture, however, was the lowest of all the markets, just below 12%.

Table 5-4 Markets that the company operates in

			Frequency	Percent	Valid Percent	Cumulative Percent
	IT	No	27	16.3	16.3	16.3
		Yes	139	83.7	83.7	100.0
	Banking	No	29	17.5	17.5	17.5
		Yes	137	82.5	82.5	100.0
	Insurance	No	89	53.6	53.6	53.6
		Yes	77	46.4	46.4	100.0
	Agriculture	No	146	88.0	88.0	88.0
		Yes	20	12.0	12.0	100.0
	Education	No	127	76.5	76.5	76.5
		Yes	39	23.5	23.5	100.0
	Manufacturing	No	113	68.1	68.1	68.1
		Yes	53	31.9	31.9	100.0

The second aspect addressed the size of the company in which the respondent is currently working. The result found that the respondents worked for either a micro-company or a medium-sized company (10-20 people worked in a micro-company and just over 100 in a medium- to large-sized company). In Table 5-4 one can see that the respondents chose the first or the last option the most, with both at 24%.

Table 5-5 Size of the company

Size of the company		Frequency	Percent	Valid Percent	Cumulative Percent
	10-20	41	24.7	24.7	24.7
	20-30	23	13.9	13.9	38.6
	30-40	27	16.3	16.3	54.8
	40-50	7	4.2	4.2	59.0
	50-60	18	10.8	10.8	69.9
	60-70	5	3.0	3.0	72.9
	70-80	4	2.4	2.4	75.3

	80-90	1	.6	.6	75.9
	100+	40	24.1	24.1	100.0
	Total	166	100.0	100.0	

With reference to the targeted audience for which the participant's company caters, the participants had three options to choose from: Business, Enterprise and Individuals. The Business purpose was the highest with 46%. For Enterprise purposes the indication was 33% and for Individuals the indication was 21%.

Out of all 166 respondents 125 (76%) indicated that they do develop mobile application software whereas the other 41 (24%) do not.

Table 5-6 If the company develops mobile applications

Answer		Frequency	Percent	Valid Percent	Cumulative Percent
	No	41	24.7	24.7	24.7
	Yes	125	75.3	75.3	100.0

This concludes the background of the company. Next the background of the last project the participants have worked on will be given.

5.2.4 Background of the projects

The next section of the questionnaire contained questions on the background of the last project the participant had worked on. The questions addressed the size of the project, the type of project they worked on, the set budget and the number of members involved in the project.

In Table 5-7 one can see that the overall project size has a normal distribution.

Table 5-7 Size of the project last worked on

Size		Frequency	Percent	Valid Percent	Cumulative Percent
	Very Small	8	4.8	4.8	4.8
	Small	47	28.3	28.3	33.1
	Medium	58	34.9	34.9	68.1
	Large	35	21.1	21.1	89.2
	Very Large	18	10.8	10.8	100.0
	Total	166	100.0	100.0	

Regarding the target platform, one can see that out of all five given choices, Android and iOS came out the strongest with 73.5% followed by iOS with 63.9%. This proves what was established in the literature under 3.1.1 that Android and iOS are the two

strongest platforms on the market. The third largest was Windows Mobile with 55.4%. As mentioned in 3.1.1 one can see that Windows Mobile was the third highest platform on the market. Blackberry came in fourth with 13.9% and this result also agrees with what was stated in the literature. Unfortunately none of the participants chose the Tizen platform.

Table 5-8 Platforms the company develops on

Platform		Frequency	Percent	Valid Percent	Cumulative Percent
Android	No	44	26.5	26.5	26.5
	Yes	122	73.5	73.5	100.0
iOS	No	60	36.1	36.1	36.1
	Yes	106	63.9	63.9	100.0
Blackberry	No	143	86.1	86.1	86.1
	Yes	23	13.9	13.9	100.0
Windows Mobile	No	74	44.6	44.6	44.6
	Yes	92	55.4	55.4	100.0
Tizen	No	166	100.0	100.0	100.0

Each individual had a specific budget for the last project they worked on. These budgets ranged from a minimum of R11 000 to a maximum of R15 000 000. The average budget out of all the participants was R740 835.

Looking at the data in Table 5-9 one can see that more than half of the participants worked on projects that involve very few members. The smallest group, 5-10 members, was the highest with 53%, whereas the second highest was a group of 10-15 members scoring 33.7%.

Table 5-9 Number of members involved in the last project worked on

		Frequency	Percent	Valid Percent	Cumulative Percent
	5-10	88	53.0	53.0	53.0
	10-15	56	33.7	33.7	86.7
	15-20	12	7.2	7.2	94.0
	20-25	1	.6	.6	94.6
	25+	9	5.4	5.4	100.0
	Total	166	100.0	100.0	

This concludes the profile of the participants. Next the set aims and objectives of this study will be given with the corresponding questions related to the aim and objective.

5.3 (1) Determine the current status of mobile application development in South Africa

In this part of the study the current status of mobile application development will be measured by looking at how many of the participants deal with MAD in South Africa. To accomplish this aim the participants needed to indicate whether or not they develop mobile application software by simply choosing between 'Yes' and 'No'. These are the results:

Table 5-10 How many participants develop mobile applications

		Frequency	Percent	Valid Percent	Cumulative Percent
	No	41	24.7	24.7	24.7
	Yes	125	75.3	75.3	100.0
	Total	166	100.0	100.0	

Here one can see that 125 out of 166, 75.3%, participants develop mobile applications whereas only 41, 24.7%, do not.

5.4 (2) Determine the success of mobile application development in South Africa

The following questions were asked to determine the outcome and the success of MAD in South Africa. In order to determine the outcome of MAD projects and then to determine their success two factors were measured: firstly, the process success of the last project the participants worked on and secondly, the product success of the last project they worked on.

5.4.1 Outcome of the last project worked on

Table 5-11 Outcome of the last project worked on

		Frequency	Valid Percent
	The project was cancelled/terminated before completion	1	.6
	The project was completed but not implemented	3	1.8
	The project was completed and implemented, but not in use anymore	12	7.2
	The project was completed and implemented, and is in use	150	90.4
	Total	166	100.0

Each of the participants needed to evaluate the outcome of the last project they worked on by choosing the appropriate statement as seen in Table 5-11. The majority of the participants (150) indicated that their last project was completed, implemented and is currently in use. Of the 166 participants 12 of those indicated that their last project was completed, implemented but not in use anymore. Only 3 participants indicated that their projects were completed but not implemented whereas only 1 indicated that the project was cancelled before completion.

5.4.2 Process success

Table 5-12 shows the questions asked to measure the process success of the last project they worked on. The table depicts the descriptive analysis of each question. A Likert scale was used for the numbers 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Totally Agree.

Table 5-12 Process success of the last project worked on

Process Success	Likert - Scale					Mean	Std. Deviation
	1	2	3	4	5		
The project was completed on schedule	5.4	15.1	31.9	30.1	17.5	3.392	1.1052
The project was completed within the budget	4.2	13.9	30.1	21.1	30.7	3.602	1.1800
The development system satisfied all the stated requirements	1.5	5.4	19.3	45.2	28.9	3.952	.8999
The speed of developing the project was high	4.8	6.6	23.5	36.1	28.9	3.777	1.0864
The productivity of developers involved with the project was high	0.6	5.4	19.9	47.6	26.5	3.940	.8578
The cost of the project is low when compared to the size and complexity of the system developed	1.8	8.4	29.5	39.2	21.1	3.693	.9577
The project achieved its goals	0.6	6.6	19.3	41.6	31.9	3.976	.9142
Overall, the project represents	0.0	4.8	28.3	34.9	31.9	3.940	.8924

excellent work							
Overall, the project was a success	0.6	4.2	19.9	39.8	35.5	4.054	.8825

One can see that overall 31.9% of the participants were neutral about their project being completed on scheduled. Most of the participants, 47.6%, agreed that they completed their last project on schedule whereas 20.5% felt their project was behind schedule.

The majority of the participants indicated that the last project they worked on has been completed within the set budget of the project with an indication of 51.8%.

In respect of the concerns of the requirements that had been set forth, most of the participants, 74.1%, believed that the last system they developed satisfied the stated requirements.

The majority, 65%, indicated that they felt the tempo with which their last project was completed was high, whereas only 11.4% indicated that the development was slow.

Almost three quarters, 74.1%, of all the participants indicated that they agreed with the high productivity of the developers from the last project. Only 6% indicated that the productivity was low and 19.9% indicated that they had a neutral perception towards this statement.

A total of 60.3% of all the participants agreed that their projects had low costs compared to the complexity of the last developed system.

Almost three quarters of all the participants, 73.5%, indicated that they believed the project achieved all the set goals. Only 7.2% felt that they did not, whereas 19.3% had a neutral perception about this statement.

At first glance one can see that none of the participants had chosen the “Totally Disagree” option, which means that there was only 4.58% who felt that their projects did not represent excellent work. A total of 66.8% indicated that they were more than satisfied with their work done on the project.

More than three quarters of all the participants, 75.3%, felt that their project was an overall success. Only 19.9% had a neutral perception about this, whereas 4.8% disagreed.

Some of the questions required individual analysis. The research variable was studied further by using factor analysis and reliability testing and will be reported next.

5.4.3 Process Success - Reliability Testing

The following table (5-13) shows the results of the factor analysis done for success on questions 18-26 where there were only two factors identified. For Factor 1 (Component 1) a total of four items had an effect, whereas at Factor 2 (Component 2) a total of five factors had an effect if they were deleted.

Table 5-13 Process success components

	Component	
	1	2
The project was completed within the budget (Q19)	.783	-.462
The speed of developing the project was high (Q21)	.738	
The project was completed on schedule (Q18)	.728	-.400
The productivity of developers involved with the project was high (Q22)	.578	-.320
The project achieved its goals (Q24)	.396	-.832
Overall, the project represents excellent work (Q25)	.499	-.788
Overall, the project was a success (Q26)	.617	-.642
The cost of the project is low when compared to the size and complexity of the system developed (Q23)		-.636
The developed system satisfied all the stated requirements (Q20)	.488	-.620

The following factor analysis was done from Table 5-13 for questions 18-26 to divide the factors into the corresponding group. The new table for questions 18-26 is Table 5-14 below.

Table 5-14 Process success factors

Cronbach's Alpha if Item Deleted			
Factor 1 - Project Management (Time & Budget)		**Factor 2 - Project Management (User Requirements)**	
The project was completed on schedule (Q18)	.598	The developed system satisfied all the stated requirements (Q20)	.745
The project was completed within the budget (Q19)	.562	The cost of the project is low when compared to the size and complexity of the system developed (Q23)	.789
The speed of developing the project was high (Q21)	.656	The project achieved its goals (Q24)	.685
The productivity of developers involved with the project was high (Q22)	.697	Overall, the project represents excellent work (Q25)	.682
Cronbach's Alpha – 0.699		Cronbach's Alpha - 0.769	

For this particular factor analysis, reliability testing was done on these chosen two factors to see whether or not they are reliable. The accepted factor for reliability is > 0.6. Both these two factors, as seen in Table 5-14, are > 0.6, where Factor 1: 0.699 is and Factor 2: 0.769. From this analysis one can see that all items will be kept under the particular factor, otherwise the factors will be more negative. However, item Q23 is greater than its Cronbach's Alpha (0.769) and will be used separately. The three items left in Factor 2 (Q20, Q24 and Q25) will become the new factor items.

5.4.4 Product Success

Table 5-15 reflects the questions asked to measure the product success of the last project they worked on. The following table indicates the descriptive analysis of each question. A Likert scale was used for the numbers 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Totally Agree.

Table 5-15 Product success on the last project worked on

Product Success	Likert - Scale					Mean	Std. Deviation
	1	2	3	4	5		
The functionality of the development is high	1.2	5.4	16.9	44.6	31.9	4.006	.9045
The reliability of the development is high	0.0	6.6	26.5	36.1	30.7	3.910	.9134
The maintainability of the development was high	1.2	5.4	33.1	35.5	24.7	3.771	.9254
The portability of the development is high	0.6	6.6	25.3	41.6	25.9	3.855	.9030
The efficiency of the development is high	0.6	6.0	15.7	42.8	34.9	4.054	.8962
The usability of the development is high	0.0	3.0	16.3	41.6	39.2	4.169	.8063
The development system meets user needs	0.6	0.0	19.3	45.2	34.9	4.139	.7620
The documentation of the development system is good	6.0	16.3	28.3	28.3	21.1	3.422	1.1664
Overall the quality of the development system is high	0.6	3.6	21.7	38.6	35.5	4.048	.8794
Overall, the users are satisfied with the development system	0.0	2.4	18.7	50.0	28.9	4.054	.7568
Overall, the development system is a success	0.6	1.2	19.3	49.4	29.5	4.060	.7683

When asked about the functionality of the development on the participant's last project, more than three quarters, 76.5%, agreed that their functionality was of a high standard. Only 6.8% disagreed on this matter.

With reference to the reliability of the development, none of the participants totally disagreed with this statement, only 6.6 partially disagreed. A total of 66.8% indicated

they agreed with the statement whereas the other 26.5% indicated they had a neutral perception towards the statement.

The following statement resided in whether or not the participant agreed/disagreed to the extent on how high their development maintainability was. Of 166 participants a 100, 60.2%, indicated that their development maintainability was high, whereas only 33.1% said they felt neutral about this. The other 11, 6.6%, participants said they do not agree with this statement.

A total of 67.5% agreed that their portability on their last development project was high, whereas 7.2% indicated that theirs was very low. The other 25.3% indicated that their portability was average.

More than three quarters, 77.7% said that their last development project was highly efficient against the other 6.6%, whose efficiency was very low.

As far as the usability of their last project was concerned, 80.8% of all the participants indicated that their product was of a high standard while the other 3% indicated that theirs was low. Note that none of the participants indicated a 1 in this matter.

One of the most important aspects of a project is catering for the user and his/her needs. An astounding 80.1% of the participants felt their product met the user's needs in the end, while only 0.6% felt they did not. The other 19.3% felt neutral about this statement therefore only meeting the user's needs in some aspects. None of the participants indicated a 2 in this matter.

Regarding the documentation of the project, 49.4% said their documentation was on standard. The other 28.3% indicated that their documentation was average whereas the other 22.3% felt theirs was not up to standard.

The overall perception on the quality of the last developed project showed that 74.1% agreed that their quality was high, whereas only 3.9% disagreed with this statement. The other 21.7% felt they produced an average quality product.

When asked about the satisfaction of the users at the end of the project development, 78.9% indicated that the users were indeed pleased with the product, whereas 18.7% felt impartial about the statement. Only 2.4% indicated that their users were not satisfied.

When looking back at the whole project, the participants needed to evaluate the last project they worked on. 78.9% indicated that their project was a complete success, whereas 1.8% indicated that it was a failure. The rest of the participants, 19.3%, felt they had a neural perception regarding this matter.

Some of the questions required individual analysis. The research variable was studied further by using factor analysis and reliability testing and will be reported next.

5.4.5 Product Success - Reliability Testing

The following table (5-16) shows the results of the factor analysis done on questions 27-37 where there was only 1 factor identified.

Table 5-16 Product success components

	Component		
	1	2	3
The reliability of the developed system is high (Q28)	.773		
Overall, the users are satisfied with the developed system (Q36)	.762		
Overall, the developed system is a success (Q37)	.754		
The functionality of the developed system is high (Q27)	.671		.373
The usability of the developed system is high (Q32)	.659		
The efficiency of the developed system is high (Q31)	.653	.459	
The developed system meets user needs (Q33)	.644		.358
Overall the quality of the developed system is high (Q35)	.611	.324	.376
The portability of the developed system is high (Q30)		.846	
The maintainability of the developed system is high (Q29)	.632	.670	
The documentation of the developed system is good (Q34)			.876

The following factor analysis was done from Table 5-16 for questions 27-37 to divide the factors into the corresponding group. The new table for questions 27-37 is Table 5-17 below.

Table 5-17 Product success factors

Cronbach's Alpha if Item Deleted	
Factor 1 – Product Development	
The functionality of the developed system is high (Q27)	.847

The reliability of the developed system is high (Q28)	.837
The maintainability of the developed system is high (Q29)	.847
The efficiency of the developed system is high (Q31)	.849
The usability of the developed system is high (Q32)	.852
The developed system meets user needs (Q33)	.856
Overall the quality of the developed system is high (Q35)	.851
Overall, the users are satisfied with the developed system (Q36)	.842
Overall, the developed system is a success (Q37)	.844
Cronbach's Alpha – 0.862	

The accepted factor for reliability is > 0.6. Factor 1, as seen in Table 5-17, is > 0.6, where Factor 1: 0.862. From this analysis one can see that all items will be kept under the particular factor, otherwise the factor will be more negative.

5.5 (3) Determine the use of project management methodologies (if any) in mobile application development.

The next section of the questionnaire was on whether or not the participants used a project management methodology. If they indicated that they use a methodology, the participants were sent to a different part of the questionnaire. That part of the questionnaire contained the questions that are applicable when using a methodology.

5.5.1 Using a project management methodology

As one can see, out of 166 participants, only 117, 70.5%, use a project management methodology in their projects. The other 49, 29.5%, however, do not use any form of project management methodologies.

Each participant had to choose if he/she used one, two or three project management methodologies. Out of a 117 participants, 89, 53.6%, indicated that they use only one methodology. The other 27, 16.3%, indicated they only use two and one participant, 0.6%, uses three methodologies. These methodologies can include any of the following: Agile, PMBOK, PRINCE2 or COBIT (which will be discussed next).

Table 5-18 Number of PMMs used

		Frequency	Percent	Valid Percent	Cumulative Percent
	1	89	53.6	76.1	76.1
	2	27	16.3	23.1	99.1
	3	1	.6	.9	100.0
	Total	117	70.5	100.0	
Missing	System	49	29.5		
Total		166	100.0		

5.5.2 Types of methodology used

Table 5-19 shows the different types of methodology and the percentage of how many are used and how many are not used. Keep in mind that the participants could have chosen more than one.

Table 5-19 Types of methodology used

PMM	Yes	No
Agile	81.7	18.3
PMBOK	12.5	87.5
PRINCE2	26.7	73.3
COBIT	1.7	98.3

One can see that out of all the PMMs, Agile is the one methodology that was used most. Out of all the participants 81.7% uses Agile whereas only 18.3% does not.

One can see that PMBOK is ranked third in respect of the PMMs used by the participants in this study. A negative 87.5% does not use PMBOK whereas a mere 12.5% used this methodology.

PRINCE2 is the second most used PMM by all the participants in this study. 26.7% of the participants uses PRINCE2 whereas the majority, 73.3%, does not.

COBIT is the leased used PMM out of all four. Only 1.7% of all the participants uses COBIT whereas the rest, 98.3%, does not.

5.6 (4) If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.

This section of the study focuses on how control and management of the projects take place if a participant does not use a PMM. This aim of the study has two parts; firstly, to determine if the participants use a PMM and then to determine how control and management take place. This will be discussed in this chapter. The second part, to understand the reasons why PMMs are not used, will be discussed in Chapter 6. After determining this, the reasons why they do not use a project management methodology will be investigated.

The questions were set up to first determine if the participants use a PMM, and if they do not, then the second part determines the reasons why they do not use a PMM. In the last couple of questions is measured how control and management take place.

5.6.1 Not using a project management methodology

Out of the 166 participants, only 49, 29.5%, do not use a project management methodology in their projects whereas the other 117, 70.5%, use a project management methodology.

Out of all the participants 47.9% said that they have considered a methodology, whereas the other 52.1% said that they have not.

Out of all the participants 21, 42.9%, out of the 49 had considered project management methodology, but decided against it. Only 36.7% never considered using a project management methodology, whereas the other 20.4% indicated that they used methodologies in the past, but abandoned them in the end.

Table 5-20 Best describes the participant's IS department

		Frequency	Percent	Valid Percent	Cumulative Percent
	Your IS department had never consider using project management methodology	18	10.8	36.7	36.7
	Your IS department had consider using project management methodology, but decided against it.	21	12.7	42.9	79.6
	Your IS department did use project	10	6.0	20.4	100.0

	management methodology in the past, but abandoned it.				
	Total	49	29.5	100.0	
Total		166	100.0		

5.6.2 Reasons for not using a PMM

The reasons for not using a PMM were determined. The table (5-21) below shows the questions and after the table the descriptive analysis is shown for each question. A Likert scale was used for the numbers 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Totally Agree.

Table 5-21 Reasons for not using a PMM

Reasons for not using a PMM	Likert - Scale					Mean	Std. Deviation
	1	2	3	4	5		
The profile of development projects in our IS department doesn't require the use of project management methodologies	10.2	12.2	32.7	34.7	10.2	3.224	1.1230
Project management methodologies are too complex or hard to use	18.4	22.4	34.7	20.4	4.1	2.694	1.1218
The current project management practice in our IS department is adequate	4.1	16.3	40.8	28.6	10.2	3.245	.9902
The experience of the system developers in our IS department reduces the need for project management methodologies	6.1	14.3	40.8	30.6	8.2	3.204	.9996
The benefits of project management methodologies use are long-term, whereas costs are incurred short term	0.0	16.3	49.0	24.5	10.2	3.286	.8660
There is a lack of experienced staff in our IS department who can effectively use project management methodologies	8.2	16.3	32.7	18.4	24.5	3.347	1.2509

New system development with project management methodologies are not compatible with legacy systems	10.2	12.2	38.8	32.7	6.1	3.122	1.0534
Our IS department lacks a suitable environment to support project management methodologies	12.2	14.3	44.9	28.6	0.0	2.898	.9627
In our IS department there is a lack of management support for the use of project management methodologies	14.3	10.2	28.6	30.6	16.3	3.245	1.2671
The learning curve of project management methodologies is very long	8.2	16.3	30.6	28.6	16.3	3.286	1.1726
The financial investment in project management methodologies is too long	8.2	16.3	44.9	16.3	14.3	3.122	1.1112
In our IS department there is a lot of uncertainty over the benefits of adopting project management methodologies	8.2	8.2	42.9	28.6	12.2	3.286	1.0607
In our IS department there is no clear objectives for adopting project management methodologies	8.2	14.3	46.9	22.4	8.2	3.082	1.0173

When asked about the use of project management methodologies in their IS department's profile, 44.9% responded that they agreed that their IS department does not require the use of a PMM. The other 22.2% responded that they do not agree with this statement whereas 32.7% has an unbiased opinion.

40.8%, felt their project management methodology are not too complex and difficult to use, whereas 24.5% felt that they are. Just more than one third, 34.7%, indicated that they have mixed perceptions towards this statement.

When asked about whether or not participants felt their current project management methodology are suitable, 40.8% indicated that they were unsure about this. The

other 38.8% indicated that they felt they are suitable whereas 20.1% said theirs are not.

40.8%, of the participants was hesitant regarding this statement whereas the minority, 20.4%, said that do they not agree with this statement. The other 38.8% said they felt that the experience of their system developers reduces the need for project management methodology in the IS department.

Weighing the use of project management methodology for long-term benefits up against cost incurred in the short term, 49% indicated they had an unbiased opinion in this matter. The other 34.7% said they agreed with this whereas 16.3% said they do not.

43.9%, of the participants felt that there is a lack of experience in the IS department staff who could effectively use project management methodologies. The minority, 25.4%, felt their staff is experienced, whereas 32.7% had a neutral perception in this regard.

38.8%, agreed that their new system development with PMM was not compatible with their legacy systems whereas 22.4% disagreed. The other 38.8% had an unbiased opinion in this regard.

44.9%, was the group that had no opinion to this statement, whereas the minority, 26.5%, indicated that they do not agree with this statement. The other 28.6% said that they felt that there is a lack of a suitable environment for PMM.

A positive feedback by 46.9% said that they agree that their department lacks management support for the use of PMM. The other 24.5% said that they disagreed with this statement and 30.6% had a neutral perception towards this statement.

44.9%, felt that the learning curve of PMM is very long whereas 24.5% said that it is not. The other 30.6% had a nonaligned perception in this regard.

When asked if the financial investment in PMM is too long a 44.9% of all the participants had a neutral perception towards this statement, whereas 30.6% said they agree. The other 24.3%, however, did not.

42.9% indicated that they were uncertain about if their IS department knows the benefits of adopting a PMM, whereas 40.6% said that they agreed. The other 16.4% disagreed on this matter.

Out of all the participants, 46.9% indicated that they had an unbiased opinion towards their department not having clear objectives for adopting a PMM, whereas 30.6% said they agree with this statement. The minority of 22.5% said they disagree.

5.6.3 Project management activities applied – not using a PMM

This section shows how control and management take place on their project by using the project management activities applied. The table (5-22) below shows each question and after the table the descriptive analysis is given. A Likert scale was used for the numbers 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Totally Agree.

Table 5-22 PM activities applied - not using a PMM

Project management activities applied – not using a PMM	Likert - Scale					Mean	Std. Deviation
	1	2	3	4	5		
We always complete a project plan for our projects	2.0	8.2	36.7	36.7	16.3	3.571	.9354
All our projects use product based planning technique	2.0	10.2	34.7	42.9	10.2	3.490	.8926
We determine our projects justification and scope	0.0	2.0	38.8	36.7	22.4	3.796	.8160
All our projects follow an effective project initiation or start-up stage	0.0	2.0	38.8	46.9	12.2	3.694	.7131
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	0.0	10.2	34.7	34.7	20.4	3.653	.9254
It is important to make project communication transparent at all levels	0.0	6.1	22.4	34.7	36.7	4.020	.9240
All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.	2.0	20.4	40.8	24.5	12.2	3.245	.9902

We have sometimes resolved management, operational and technical issues during the course of projects	0.0	14.3	38.8	36.7	10.2	3.429	.8660
All our projects follow a calendar or core project plan with intended start and finish dates	2.0	4.1	34.7	44.9	14.3	3.653	.8552
All our projects have defined project management roles	20.4	20.4	28.6	18.4	10.2	2.755	1.2671
All our projects follow effective cost management	0.0	6.1	28.6	44.9	20.4	3.796	.8411
Our Clients, Suppliers and Users of the projects are organized and coordinated so that the required outcome is within budget, on time and to specification	4.1	8.2	32.7	44.9	10.2	3.531	.9377
Effective project procurement management is an important process	0.0	8.2	32.7	38.8	20.4	3.490	.9381
All our projects have a clear focus on where to prioritize and place project resources	0.0	6.1	34.7	44.9	14.3	3.714	.8898
We often use the same project management methodology for similar projects	30.6	18.4	16.3	24.5	10.2	3.673	.8007
We understand the background or history of the projects we undertake	0.0	2.0	20.4	59.2	18.4	2.653	1.4076
We estimate the time, money and people we need for the job	0.0	2.0	18.4	51.0	28.6	3.939	.6894
We hold regular meetings with our clients	2.0	10.2	24.5	38.8	24.5	4.061	.7474
We carry out a project closure process after completion	0.0	4.1	32.7	32.7	30.6	3.735	1.0160

Our project approach requires decision making and phasing in managing the project	4.1	10.2	38.8	34.7	12.2	3.898	.8955
The scale of the projects influences the methodology to be used	2.0	10.2	38.8	40.8	8.2	3.408	.9772
Our methodology removes the causes of failure in our projects	6.1	18.4	30.6	34.7	10.2	3.429	.8660
The use of methodologies influences the entire project life cycle from conception to project closure	6.1	12.2	46.9	30.6	4.1	3.245	1.0710
The current economic downturn has affected our use of project methodologies	8.2	24.5	44.9	18.4	4.1	3.143	.9129

The majority, 53%, indicated that they use a project plan for their projects, whereas the minority, 10.2%, indicated they do not. The other 36.7% was unsure in this matter.

More than half, 53.1%, said that they use a product-based planning technique for their projects whereas only 12.2% said they do not. The other 34.7% indicated that they were unsure in this regard.

Out of all the participants 59.1% agreed that they determine project justification and scope, but only 2% disagreed. The other 38.8% indicated that they have no knowledge of this.

59.1% agreed that they follow an effective project initiation or start-up stage for their projects. Only 2% indicated that they have no such stage and 38.8% had a nonaligned knowledge of this.

The majority, 55.1%, said they do carry out stage reviews on all their projects whereas the minority, 10.2%, said they do not. The other 34.7% indicated that they have a neutral perception on this matter.

Out of all the participants 71.4% said they felt it is important to make project communication transparent to all levels, whereas 6.1% said it is not. The other 22.4% indicated that they have an unbiased opinion towards this statement.

In respect of the building of a physical deliverable for the customer to sign off, 36.7% of the participants agreed with this statement whereas the other 22.4% disagreed. The 40.8% that is left had mixed perceptions towards this statement.

Out of all the participants 46.9% said that they do sometimes resolve management, operational and technical issues during the course of their project, whereas 14.3% said that they do not. The other 38.8% had no knowledge of this matter.

A positive feedback of 59.2% indicated that they follow a project plan with start to finish dates for the projects they take on. The minority, 6.1%, indicated that they do not follow a calendar project plan whereas the other 34.7% said that they had a neutral perception regarding this matter.

Out of the entire participant group, 28.6% indicated that they do have project management roles in their projects whereas an astounding 42.8% indicated that they do not. The rest of the 28.6% had a neutral perception to the statement.

The majority, 65.3%, believed that they follow effective cost management. The minority, 6.1%, said they do not whereas the 44.9% that is left had a neutral perception towards this matter.

55.1% indicated that they agree with this statement that the necessary personnel are organized and coordinated to ensure they are within budget, on time and to specification. The minority, 12.3%, said they felt the opposite whereas the other 32.7% had an impartial view on this.

The majority, 59.2%, indicated that they felt effective project procurement is an important process in their projects, the other 8.2% felt that it is not whereas 32.7% indicated that they do not have an opinion on this matter.

The majority, 59.2%, felt that they have a clear focus on where to prioritize and place project resources on their projects. The minority, 6.1%, said they do not have a clear focus. The other 34.7% has a neutral perception in this regard.

34.7% indicated that they use the same PMM for similar projects whereas 49% said that they do not use the same PMM. The other 16.3% said they were unsure on this matter.

More than three quarters, 77.6%, felt that they understand the background of their last project whereas only 2% felt they do not. The other 20.41% felt they had an impartial perception towards this statement.

Out of all the participants 79.6% said that they do estimate time, money and people needed for the job on the project they work on. 2% said they do not. The other 18.4% did not have an opinion on the statement.

The majority, 63.3%, indicated that they hold regular meetings with their clients. The minority, 12.2%, indicated that to do not hold regular meetings whereas 24.5% indicated they can hold meetings more regularly.

The majority, 63.3%, indicated that they do carry out a project closure process after completion whereas 4.1% said that they do not. The other 32.7% indicated that they were unsure.

46.9% said that they agree with the fact that their project approach requires decision making and phasing in managing their project. However, 14.3% said they do not follow this approach. The other 38.8% said that they were unsure about this.

Out of all the participants 49.0% said that they felt that the scale of their projects influences the method that they use whereas 12.2% said they felt the opposite. The other 38.8% said that they do not have an opinion on this statement.

44.9%, indicated that they felt their methodology removes causes of failure in their projects. The minority, 24.5%, said their methodology does not, whereas 30.6% had a neutral perception in this regard.

Out of all the participants 46.9% had no opinion to methodologies that influences the entire project life cycle from conception to project closure. The other 36.7% indicated that they agree with this statement whereas 18.3% indicated that they do not.

32.7% of all the participants said they do not feel the economic downturn has affected their use of project methodologies, whereas 22.5% agreed. The other 44.9% had no opinion on this statement.

Some of the questions required individual analysis. The research variable was studied further by using factor analysis and reliability testing and will be reported next.

5.6.4 PM activities applied – non-PMM use - Reliability Testing

The PM activities if the participants do not use a PMM will be tested next. The factors will be determined and then tested in the Cronbach's Alpha to see if they are acceptable or not.

Table 5-23 Reliability testing done on reasons and PM activities - not using PMM components

	Component					
	1	2	3	4	5	6
The current economic downturn has affected our use of project methodologies	.774					
Our project approach requires decision making and phasing in managing the project	.624	-.309		-.363	.488	-.416
We estimate the time, money and people we need for the job	.550			-.387		-.310
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	.535		.397	-.491	.413	
We carry out a project closure process after completion		-.861				
A project support office is set up to assist project managers with their work like administrative work needed, keeping files and arranging meetings especially during large projects		-.810				-.445
The use of methodologies influences the entire project life cycle from conception to project closure		-.527		-.424		
It is important to make project communication transparent at all levels						
We always complete a project plan for our projects			.864			
All our projects use a product-based planning technique	.306		.739			
All our projects follow effective cost management		-.357	.594			
We hold regular meetings with our						

clients						
We have sometimes resolved management, operational and technical issues during the course of projects						
We understand the background or history of the projects we undertake				-.865		
All our projects follow an effective project initiation or start-up stage				-.761	.336	-.380
All our projects have a clear focus on where to prioritize and place project resources	.358			-.655	.364	
We often use the same project management method for similar projects		-.303			.850	
All our projects have defined project management roles			.325		.799	
All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.				-.372	.661	-.308
The scale of the projects influences the methodology to be used		-.420		-.525	.569	
All our projects follow a calendar of core project plan with intended start and finish dates						-.792
Effective project procurement management is an important process	.333	-.321		-.310	.368	-.676
Our methodology removes the causes of failure in our projects	.302			-.518	.493	-.571

The following factor analysis was done from Table 5-23 for questions 84-108 to divide the factors into the corresponding factors. The new table for questions 84-108 is Table 5-24 below.

Table 5-24 Reliability testing done on reasons and PM activities - not using PMM factors

Cronbach's Alpha if Item Deleted									
Factor 1 – Resource Availability		**Factor 3 – Cost Management**		**Factor 4 – Project Kick-Off**		**Factor 5 – Selection of PMM**		**Factor 6 – Time Management**	
The current economic downturn has affected our use of project methodologies (Q108)	.685	We always complete a project plan for our projects (Q84)	.359	We understand the background or history of the projects we undertake	.536	We often use the same project management method for similar projects	.630	All our projects follow a calendar of core project plan with intended start and finish dates (Q92)	.610

Our project approach requires decision making and phasing in managing the project (Q104)	.607	All our projects use product based planning technique (Q85)	.558	All our projects follow an effective project initiation or start-up stage	.619	All our projects have defined project management roles	.635	Effective project procurement management is an important process (Q97)	.425
We estimate the time, money and people we need for the job (Q101)	.526	All our projects follow effective cost management (Q94)	.672	All our projects have a clear focus on where to prioritize and place project resources	.713	All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.	.693	Our methodology removes the causes of failure in our projects (Q106)	.467
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	.532					The scale of the projects influences the methodology to be used	.730		
Cronbach's Alpha 0.657 Mean – 3.495		Cronbach's Alpha 0.643 Mean – 3.619		Cronbach's Alpha 0.712 Mean – 3.769		Cronbach's Alpha 0.738 Mean – 3.020		Cronbach's Alpha 0.608 Mean – 3.537	

The accepted factors for reliability are > 0.6. Factor 1, Factor , Factor 4, Factor 5 and Factor 6, as seen in Table 5-24, is > 0.6, where Factor 1: 0.657, Factor 3: 0.643, Factor 4: 0.712, Factor 5: 0.738 and Factor 6: 0.608. From this analysis one can see that not all items will be kept under the particular factor. Factor 1 will become the two remaining items, Q101 and Q104, which are left of this particular factor. Item Q108 of Factor 1 will be used separately. Factor 3 will become the two remaining items, Q84 and Q85, which are left of this particular factor. Item Q94 of Factor 3 will be used separately.

5.7 (5) If project management methodologies are used, determine how intensely, widely and strictly they are used.

This section determines how intensely, widely and strictly the individuals use their PMMs. Table 5-25 shows the results of these questions followed by the descriptive analysis. A Likert scale was used for the numbers 1 to 10 where 1 being not intensely, widely or strictly and 10 being very.

Table 5-25 How Intensely, Widely and Strictly PMMs are used

PM Activities applied – using a PMM	1	2	3	4	5	6	7	8	9	10	Mean	Std. Deviation
How intense do you use the project management methodology?	0.0	0.0	0.0	4.3	9.5	9.5	27.6	25.9	11.2	12.1	7.431	1.5782
How widely do you use the project management methodology in the project? (Number of people in the company)	0.0	0.9	0.9	5.2	8.6	12.1	33.6	21.6	4.3	12.9	7.164	1.6834
How strictly are you regarding the use of the project management methodology?	0.0	0.0	0.9	4.3	8.6	19.0	25.9	26.7	7.8	6.9	7.103	1.5058

The participants had to score the statement on a scale from 1 to 10, 1 being not intense at all and 10 being very intense. One can see that none of the participants chose options 1, 2 and 3, which meant that all the participants use their methodology to a great extent. Most of the participants chose a 7 or an 8, indicating that their methodology is used a great deal but not fully. Only 12.1% indicated that they use their methodology to the fullest.

The participants had to score the statement on a scale from 1 to 10, 1 being not wide enough and 10 being used by everyone. Again here one can see that most of the participants chose a 7 or an 8 for this statement. None of the participants indicated a 1 on this statement.

The participants had to score the statement on a scale from 1 to 10, 1 being not strictly enough and 10 being used by everyone. The majority of the participants indicated a 6, 7 or an 8, indicating that they use the methodology very strictly but not to the fullest.

5.8 (6) If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.

This section determines that if a PMM is used, what the reasons are and why the individual uses that particular PMM and also determines the activities performed. This aim of the study has two parts, namely if the participants use a PMM and then what activities are performed. This will be discussed in this chapter. The second part, to understand the reasons why the specific PMM is used, will be discussed in Chapter 6. Table 5-26 shows the results followed by the descriptive analysis. A Likert scale was used for the numbers 1 to 5 where 1 = Totally Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Totally Agree.

5.8.1 PM activities applied

Table 5-26 PM activities applied

Project Management activities applied (Using a PMM)	Likert – Scale					Mean	Std. Deviation
	1	2	3	4	5		
We always complete a project plan for our projects	0.9	8.6	19.8	41.4	29.3	3.897	.9544
All our projects use product based planning technique	2.6	6.0	26.7	44.8	19.8	3.733	.9358
All our projects follow an effective	3.4	6.9	29.3	31.0	29.3	3.759	1.0601

project initiation or start-up stage							
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	0.9	8.6	25.9	42.2	22.4	3.767	.9265
It is important to make project communication transparent at all levels	0.0	0.9	12.9	34.5	51.7	4.371	.7405
All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.	1.7	7.8	20.7	39.7	30.2	3.888	.9849
All our projects follow a calendar of core project plan with intended start and finish dates	1.7	6.0	23.3	38.8	30.2	3.897	.9635
All our projects have defined project management roles	0.0	6.9	25.9	39.7	27.6	3.879	.8959
All our projects follow effective cost management	1.7	6.9	20.7	47.4	23.3	3.836	.9226
We have sometimes resolved management, operational and technical issues during the course of projects	0.9	4.3	26.7	33.6	34.5	3.966	.9319
A project support office is set up to assist project managers with their work, such as administrative work needed, keeping files and arranging meetings especially during large projects	7.8	14.7	29.3	30.2	18.1	3.362	1.1677
Effective project procurement management is an important process	4.3	6.0	18.1	36.2	35.3	3.922	1.0807
All our projects have a clear focus on where to prioritize and place project resources	1.7	7.8	22.4	36.2	31.9	3.888	1.0024

We often use the same project management method for similar projects	1.7	6.9	13.8	36.2	41.4	4.086	.9919
We understand the background or history of the projects we undertake	0.9	1.7	15.5	46.6	37.9	4.190	.7903
We estimate the time, money and people we need for the job	4.3	4.3	16.4	34.5	40.5	4.026	1.0670
We hold regular meetings with our clients	0.0	7.8	25.0	31.0	36.2	3.957	.9636
We carry out a project closure process after completion	2.6	6.9	17.2	43.1	30.2	3.914	.9919
Our project approach requires decision making and phasing in managing the project	1.7	8.6	13.8	42.2	33.6	3.974	.9909
The scale of the projects influences the methodology to be used	4.3	6.9	22.4	37.9	28.4	3.793	1.0674
Our methodology removes the causes of failure in our projects	1.7	12.9	25.9	37.1	22.4	3.655	1.0224
The use of methodologies influences the entire project life cycle from conception to project closure	1.7	6.9	21.6	46.6	23.3	3.828	.9257
The current economic downturn has affected our use of project methodologies	9.5	22.4	34.5	20.7	12.9	3.052	1.1560

A total of 70.7% of all the participants indicated that they always complete a project plan for their projects whereas only 8.8% said that they do not.

When asked about the product-based planning technique, 64.6% said that they do use such a technique, whereas 8.6% said they do not use such a technique.

Project start-up is an important aspect of each starting point in any project. As a result 60.3% of the participants indicated that they have an effective project initiation stage. The other 10.3% indicated they do not have such a stage in their projects.

The majority gave positive feedback on this statement with 64.6% saying that they carry out stage reviews on their projects. A slight negative feedback of 9.5% said they ignore stage reviews and the other 25.9% had a nonaligned opinion regarding this statement.

When asked to indicate whether or not the participant felt that communication should be transparent to all organizational levels, 86.2% indicated they felt strongly in this matter. The other 0.9% said that they disagreed while the other 12.9% had mixed perceptions towards this statement.

In respect of the building of a physical deliverable for the customer to sign off, 69.9% of the participants agreed with this statement whereas the other 9.5% disagreed. 20.7% had mixed perceptions toward this statement.

48.2% indicated that they follow a project plan with start to finish dates for the projects they take on. The minority, 7.7%, indicated that do not follow a calendar project plan whereas the other 23.3% said that they had a neutral perception regarding this matter.

Out of the entire participant group, 69.0% indicated that they have project management roles in their projects whereas 6.9% indicated that they do not. The rest of the participants, 25.9%, had mixed perceptions in this regard.

Most of the participants, 70.4%, agreed that they followed an effective cost management plan for the last project they worked on. The other 20.7% had a neutral perception in this regard whereas the other 8.6% did not agree.

In Table 5-26 one can see that most of the participants resolve management, operational and technical issues in their projects. Just more than one quarter, 26.7%, of the participants had an unbiased opinion on this statement. The other 5.2% said that they do not resolve these issues during the course of their projects.

48.3%, agreed with the statement that a project support office is there to assist project managers with their administrative work. The minority, 22.5%, felt that this is

not the role of a project support office whereas 29.3% indicated they had mixed perceptions toward this statement.

When asked, the majority of the participants, 71.5%, indicated that they felt procurement management is an important process. The other 10.3% indicated that procurement management is not important while 18.1% had a nonaligned opinion.

A positive 68.1% indicated that when they take on a project, they have a clear focus regarding where to prioritize project resources. There was neutral perception by 22.4% towards this statement and a 9.5% negative feedback.

When asked if the participants agreed that they use the same project management methodology for similar projects, 77.6% said they do whereas the other 8.6% said they do not. The other 13.8% said that they had an unbiased opinion.

The next statement was regarding whether or not the participants felt they understood the background of the project they undertook. 84.5% of them clearly agreed with the statement. Only 2.6% said that they did not whereas the other 12.9% had mixed perceptions about this statement.

Participants had to indicate how they felt about the time, money and people needed for the last project they worked on. Exactly 75% of the participants agree that they estimate these aspects of their projects. The other 8.6% of the participants said that they do not estimate these factors whereas 16.4% had an unbiased opinion.

A positive 67.2% indicated that they hold regular meeting with their clients and 7.8% indicated that they do not hold that many meetings. The other 25.0% indicated that they do not hold as many meetings with their clients as they should.

After a project is completed there is a project closure process to be followed, 73.3% of the participants said that they do carry out this process. Only 17.2% said that they had a neutral perception towards this statement. The other 9.5% said that have no such process at the end of their projects.

The majority, 75.8%, indicated that their project approach does require decision making and phasing. There was a neutral perception of 13.8% of participants towards this statement while the minority, 10.3%, felt otherwise.

A positive 66.3% indicated that they believed the scale of the projects influences the method that will be used. The minority, 11.2%, disagreed with this statement whereas the other 22.4% had mixed perceptions in this regard.

Here one can see that the majority, 59.5%, felt that their methodology removes causes of failures in their projects whereas 14.6% felt otherwise. The other 25.9% has an unbiased opinion in this matter.

In Table 5-26 one can see that 69.9% felt that their use of methodologies influenced their entire project life cycle whereas 8.6% felt that it does not. The other 21.6% had a neutral perception towards this statement.

Considering the economic downturn as an implication in the use of project management methodology, only 33.6% said that it had an effect on their project. The other 31.9% disagreed with the statement whereas 34.5% had an impartial opinion.

Some of the questions required individual analysis. The research variable was studied further by using factor analysis and reliability testing and will be reported next.

5.8.2 PM Activities applied- Using a PMM – Reliability Testing

Next the PM activities will be tested if the participants do not use a PMM. The factors will be determined and then tested in the Cronbach's Alpha to see if they are acceptable or not.

The following table (5-27) shows the results of the factor analysis done on questions 45-67 where there were six factors identified, but only four could be used for reliability.

Table 5-27 PM Activities applied- Using PMM components

	Component					
	1	2	3	4	5	6
We estimate the time, money and people we need for the job	.852					-.383
All our projects have a clear focus on where to prioritize and place project resources	.741				.377	-.326
We carry out a project closure process after completion	.688	.326	.420			-.423
We hold regular meetings with our clients	.685		.328			

Effective project procurement management is an important process	.603			.341		-.584
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	.583		.317		.378	-.507
All our projects have defined project management roles	.569	.393	.468	.447		
Our project approach requires decision making and phasing in managing the project	.558	.380	.333		.428	-.465
We have sometimes resolved management, operational and technical issues during the course of projects	.539			.318	.413	
We understand the background or history of the projects we undertake	.525			.378		
The scale of the projects influences the methodology to be used		.821				
The current economic downturn has affected our use of project methodologies		.722				
Our methodology removes the causes of failure in our projects		.671			.330	-.350
All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.			.811			
All our projects follow effective cost management	.343	.410	.780			-.343
All our projects follow a calendar of core project plan with intended start and finish dates	.429		.680	.356		
All our projects use product based planning technique	.306			.792	.328	-.344
We always complete a project plan for our projects (Q45)			.372	.724		-.319
The use of methodologies influences the entire project life cycle from conception to project closure	.560			.636	.349	-.307
It is important to make project communication transparent at all levels					.707	
We often use the same project management method for similar projects	.377				.665	-.325
A project support office is set up to assist project managers with their work like administrative work needed, keeping files and arranging meetings especially during large projects	.304			.386		-.824
All our projects follow an effective project initiation or start-up stage	.453		.417	.331	.393	-.731

The following factor analysis was done from Table 5-27 for questions 45-67 to divide the factors into the corresponding group. The new table for questions 45-67 is Table 5-28 below.

Table 5-28 PM Activities applied- Using PMM factors

Cronbach's Alpha if Item Deleted							
Factor 1 – General PM activities		**Factor 2 – Activities regarding choices**		**Factor 3 – Activities regarding time**		**Factor 4 – Project Planning**	
We estimate the time, money and people we need for the job	.835	The scale of the projects influences the methodology to be used (Q64)	.444	All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.	.674	All our projects use product based planning technique (Q45)	.533
All our projects have a clear focus on where to prioritize and place project resources	.844	The current economic downturn has affected our use of project methodologies	.559	All our projects follow effective cost management (Q53)	.482	We always complete a project plan for our projects (Q45)	.700
We hold regular meetings with our clients	.852	Our methodology removes the causes of failure in our projects	.595	All our projects follow a calendar of core project plan with intended start and finish dates	.645	The use of methodologies influences the entire project life cycle from conception to project closure	.626
Effective project procurement management is an important process	.854	Cronbach's Alpha – 0.634 Mean – 3.500		Cronbach's Alpha – 0.695 Mean – 3.874		Cronbach's Alpha – 0.712 Mean – 3.819	
We carry out a project closure process after completion	.842						
We understand the background or history of the projects we undertake	.863						
All our projects have defined project management roles	.855						
We have sometimes resolved management, operational and technical issues during the	.858						

course of projects	
We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations	.849
Our project approach requires decision making and phasing in managing the project	.850
Cronbach's Alpha – 0.863 Mean – 3.948	

The accepted factor for reliability is > 0.6. Factor 1, Factor 2, Factor 3 and Factor 4, as seen in Table 5-28, is > 0.6, where Factor 1: 0.863, Factor 2: 0.634, Factor 3: 0.695 and Factor 4: 0.712. From this analysis one can see that all items will be kept under the particular factor.

5.9 (7) If project management methodologies are used, how effectively are they used?

In this section it is determined whether a PMM is used and how effectively it is used in the participant's projects. For this we have used t-test. It is statistical meaningful if $p<0.5$; $p<0.1$ and $p<0.001$.

There are particular questions that we have evaluated according to the t-test. When looking at t-test values, 0.8 indicates a large effect, i.e. plainly evident, 0.5 indicated a medium effect, i.e. observable and 0.2 indicates a small effect, i.e. hardly visible (Ellis & Steyn, 2003).

5.9.1 Do you develop mobile application software? (Q10)

Table 5-29 was drawn up on Q10 for the process success, product success and PM Activities Applied – Using PMM. From this table one can see that from Q10 there was a medium effect on the process success and a medium-to-small effect on

product success. The other questions will be considered to have a small effect on Q10.

Table 5-29 Developing MAD (Q10)

Do you develop mobile application software?		N	Mean	Std. Deviation	Std. Error Mean	Effect Sizes
Process Success	No	41	4.0623	.62363	.09740	**0.53**
	Yes	125	3.7324	.61624	.05512	
Product Success	No	41	4.0510	.58531	.09141	**0.22**
	Yes	125	3.9215	.53226	.04761	

5.9.1.1 Process Success

Q18-Q26 indicates the questions involving the process success of the last project the participants worked on with a medium effect size of 0.53. One can see that the participants who develop mobile applications struggle more with the process of the development than those who do not.

5.9.1.2 Product Success

Q27-Q37 indicates the questions involving product success of the last project the participants worked on with a small effect size of 0.22. Looking at the table (5-29) one can see that the participants who do not develop mobile software are more successful in their products than those who do.

5.9.2 Do you use a project management methodology? (Q38)

Table 5-30 shows the t-test that was done on Q38 for the corresponding question range below. One can see from the table that only the bottom two range questions will not be used, because of their inconclusive effect sizes. The other three will be used on the particular question.

Table 5-30 Using a PMM (Q38)

Do you use a project management methodology?		N	Mean	Std. Deviation	Std. Error Mean	Effect Sizes
Process Success	No	49	3.4717	.64331	.09190	**0.75**
	Yes	117	3.9573	.57232	.05291	
Product Success	No	49	3.7013	.59265	.08466	**0.60**
	Yes	117	4.0591	.49193	.04548	

5.9.2.1 Process Success

Q18-Q26 indicates the questions involving the process success of the last project the participants worked on with a large effect size of 0.75. One can see that the

participants who use a PMM are more successful with their processes than those who do not use a methodology.

5.9.2.2 Product Success

Q27-Q37 indicates the questions involving product success of the last project the participants worked on with a medium effect size of 0.60. One can see that the participants who use a PMM are more successful in their products than those participants who do not use a methodology.

In this chapter the various aims and objectives of this study were stated as well as how this study intended to accomplish those aims and objectives through the various questions in the questionnaire. The descriptive analysis, reliability testing, factor analysis and the t-test of the data were given. The next chapter will include the findings in the qualitative data from the interviews and the open questions in the questionnaire.

CHAPTER 6
QUALITATIVE RESULTS

As previously mentioned the purpose of this chapter is to report the findings of the interviews and the open questions in the questionnaires. There are two of the seven aims and objectives that are met through these qualitative results:

1. If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.
2. If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.

The first section of this chapter will consist of the findings in the interviews that were conducted and secondly, the open questions answered in the questionnaire. For each of these questions a table was constructed. In the table there are three elements:

Codes: The codes are distinct key words given to the response of each entry of the participants to the corresponding question. Each code is described at the end of each table to give an overview of what the respondents' meant by the answer they gave to the corresponding question.

The codes given in this chapter are the following:

- **IU:** These are the results of the respondents from the interviews that uses a PMM
- **IN:** These are the results of the respondents from the interviews that does not use a PMM
- **QU:** These are the results of the respondents from the questionnaires that do use a PMM
- **QN:** These are the results of the respondents from the questionnaire that does not use a PMM

Respondents: The respondents who gave the same description to that particular code given.

Number: The number of respondents who gave the same answers to the given question.

6.1 Interviews

In this section the interviews performed will be reported and discussed.

6.1.1 General Problems / Challenges

The following table (6-1) reports the findings regarding the general problems and challenges project managers face in the everyday projects that they undertake.

Table 6-1 General problems

General Problems / Challenges		
Codes	Respondents	# Number
Lack of support	IU1	1
Unclear Requirements	IU1, IU6, IU7, IU8, IU9, IU10, IU12, IU13, IU18, IU24, IU27, IU31, IU36, IU46, IU49	15
Lack of budget management	IU1, IU7, IU9, IU10, IU20, IU29, IU30	7
Complexity	IU3, IU5, IU10, IU15	4
Time management	IU3, IU7, IU13, IU18, IU19, IU20, IU22, IU29, IU30, IU42, IU43, IU49	12
Project changes control	IU4, IU12, IU18, IU23	4
Outsourcing	IU5, IU6, IU8	3
Scope Creep	IU5, IU7, IU9, IU11, IU12, IU19, IU30, IU32	8
Employees	IU6, IU7, IU8, IU10, IU26, IU35, IU41, IU48	8
Communication	IU4, IU8, IU32	3

General Problems / Challenges		
Codes	Respondents	# Number
Stakeholder Expectations & Understanding	IU7, IU8, IU9, IU10, IU18, IU43, IU46	7
Inadequate documentation	IU9	1
Software Technology	IU12, IU13, IU17, IU21, IU33, IU34, IU36, IU40, IU44, IU47, IU49	11
Hardware Technology	IU13, IU25, IU34, IU37, IU47	5
Quality	IU13	1
Adaptability	IU15	1
Lack of PM knowledge	IU16, IU19, IU26	3
Resource Availability	IU19, IU22, IU28, IU29, IU41	5
Unforeseen Problems	IU29, IU30, IU39	3
Feature Creep	IU50	1

The following are the codes used in Table 6-1 on how the individuals responded towards general problems and the challenges they face:

Lack of support: This was in respect of the company in general. The respondents felt that they did not have the necessary support from the company.

Unclear Requirements: With reference to the requirements of the project, the respondents felt that the clients did not give the correct and full requirements of the project and started adding requirements later. The clients sometimes assume that their project manager knows what their requirements are.

Lack of budget management: There was no in-depth analysis done on the budget of the projects, because of other features that are added later in the project and this leads to the budget being overrun.

Complexity: The project becomes too complex from what was intended at the start of the project, because of requirements that are added and changed later in the project. The stakeholders also do not understand the complexity of certain projects.

Time management: Lack of time management is predicted and worked out at the start of the project and results in the project being delivered late to the client.

Project changes control: Changes made to the project that were not anticipated.

Outsourcing: When projects are outsourced to another company to perform the task. This was one of the major problems and the project managers felt that this is not productive. Products returned that were not developed correctly, which leads to budget overspends and time extensions.

Scope Creep: When the stakeholders add more features, etc. to the project during the development. This makes for more work for the developers and results in the scope that needs to be changed. With these changes the budget, time, resources, etc. need to be adapted.

Employees: Employees not performing to the standard they are set and not having knowledge of the work that needs to be done. This results in other employees taking on more tasks than anticipated.

Communication: The lack of company and management communication to the project groups, As well as a lack of communication between the clients and the project managers.

Stakeholder Expectations and Understanding: Stakeholders do not understand the developing environment. This point towards stakeholders not taking into account man-hours, time and money for the processes and raises the expectations that it can be done in a short time, with a low budget and a few people to produce a large complex system.

Inadequate documentation: Documentation was incomplete for the project team, which resulted in unclear requirements and miss communication on the project.

Software Technology: Software that was not working properly for each particular project, which then results in the project being behind schedule and sometimes requiring other software that was not in the budget.

Hardware Technology: Hardware that was incompatible with the current system. This included new technologies, network technologies, etc.

Quality: The quality of the work delivered from the employees is not up to standard.

Adaptability: The stakeholders are not always keen on adapting when change occurs.

Lack of PM knowledge: Project managers lack some knowledge of managing projects, communicating to the clients and the project team, not conducting adequate time and budget control and cannot adapt when the project changes.

Resource Availability: Some resources that the clients want for the project are not available or compatible, so then alternatives must be substituted and added.

Unforeseen Problems: Problems that were not anticipated arise and the stakeholders and the project team need to adapt to the change. This is very challenging most of the time.

Feature Creep: More features to be added to the project while development is in process. Clients want to add more to the project that was not initially agreed to.

This concludes the section for general problem / challenges project managers' face when using a PMM. The next section consists of the project management tools that are used.

6.1.2 Project management tools

The following section of the interview deals with what type of project management tools the participants use in their projects. Project management tools refer to how they communicate and exchange information, coding, etc. They following table (6-2) represents these findings:

Table 6-2 Project management tools used

Project management tools		
Codes	Respondents	# Number
Slack	IU1, IU5, IU6, IU8	4
Skype	IU1, IU4, IU5, IU6, IU8	5

Project management tools		
Codes	Respondents	# Number
Emails	IU2, IU4, IU5, IU7, IU8, IU9, IU10, IU15, IU22, IU30, IU32, IU33, IU35, IU37	14
Conference Calls	IU23, IU31	2
Assura	IU4, IU11	2
MS Project	IU2, IU18, IU19, IU20, IU24, IU29	6
SharePoint	IU20, IU28	2
Excel	IU2, IU12, IU17, IU38	4
Meetings	IU2, IU3, IU6, IU9, IU15, IU22	6
Internal Company System	IU7, IU13, IU14, IU16	4
Reports	IU7, IU8, IU9, IU11, IU17, IU24	6
Trello	IU10, IU22, IU25, IU30	4
Jira	IU12, IU21, IU36	3
IExpext	IU23, IU30	2
Google Drive	IU11, IU25, IU26	3
Other (Toggl, Asana, BugHead, HiTask, Instantis, OneNote, IM, Bazagi, Odoo)	IU4, IU11, IU22, IU23, IU25, IU26, IU27, IU34, IU37	9

The above table (6-2) shows tools that project managers use to communicate, manage everyday activities, etc.

6.1.3 Why the particular PMM?

Table 6-3 reports the findings of what the participants' answers were when asked why they chose the particular PMM:

Table 6-3 Reasons for using a PMM

Why did you choose the particular PMM?		
Codes	**Respondents**	**# Number**
Company Standard	IU1, IU2, IU4, IU10, IU13, IU15, IU31, IU40	8
Development Type	IU1, IU5, IU6, IU7, IU8	5
Company Environment	IU1, IU5, IU9, IU32	4
Suits company projects	IU20, IU24, IU25, IU29, IU32, IU43, IU45	7
PM understands methodology	IU7, IU8, IU9, IU10	4
Fast	IU11, IU14, IU17, IU27, IU34, IU44	6
Flexible	IU11, IU12, IU34, IU46, IU48	5
Efficient	IU16	1
Change Control	IU33, IU34, IU41, IU43, IU45	5
Caters to unique needs	IU25, IU30	2
Adaptable	IU13, IU48	2
Ease of use	IU37, IU48	2
Releases	IU3	1
PM activities control	IU12, IU13, IU14, IU17, IU26, IU33, IU34, IU49	7

The following are the codes used in Table 6-3 on how the individuals responded to why they have chosen the particular PMM:

Company Standard: Project managers have to use the set project management methodology that is set by the company. Certain companies have a predefined methodology that must be used within the company.

Development Type: Project managers use the PMM because it best suits the type of development they do within the company.

Company Environment: Project managers use the PMM because it best suits the type of environment they are in within the company. The types of environment mentioned here are where one works in a high-phased agile type.

Suits company projects: Project managers choose a methodology because it best suits the types of project they work on in the company.

PM understands methodology: A project manager is appointed to the company for his/her set of knowledge about a certain PMM. This project manager understands the methodology and knows how to implement it within the company.

Fast: A project manager uses a PMM because of its fast processes. In this case the respondent was talking about the agile methodology on small projects.

Flexible: A project manager chooses a PMM for its flexibility within each dynamic working environment when developing.

Efficient: Project managers use a PMM for the efficiency it provides within the working environment within the company. Product development needs to be fast and effective.

Change Control: A project manager chooses a PMM for its ability to perform change control during the development of the product. During the development of project many changes are made to the project and a PMM allows the project manager to carry out change control management when needed.

Caters for unique needs: Each project, company, individual, etc. has a unique need in respect of the development of certain products. A PMM helps project managers to cater for those unique needs.

Adaptable: A project manager chooses a PMM because the methodology is adaptable to other projects as well as when change occurs within the project.

Ease of use: A project manager uses a PMM because it is easy to understand, easy to use and easy to implement in the company.

Releases: Companies use a PMM for its fast yet short releases in the project. This helps the development process to go faster.

PM activities control: Project managers' activities are very important when managing projects. Respondents felt that having a PMM they can perform all their project management activities control during the lifetime of the project development.

This concludes the section on the reasons project managers' use a PMM. The next section consists of why project managers/companies do not use a PMM.

6.1.4 Why not use a PMM?

Table 6-4 reports the findings of what the participants' answers were when asked why they are not using a PMM:

Table 6-4 Why not using a PMM

Why don't you use a PMM?		
Respondents	Codes	**# Number**
IN1	No standard Current structure works	2
IN2	Not suited to the company Own methods	2
IN3	Company procedure	1
IN4	Different project = Different procedure	1
IN5	Own methods	1
IN6	There is no need in the company for a PMM	1
IN7	In process to adopt a PMM	1
IN8	No Project manager that has the knowledge Own methods	2
IN9	Own methods	1
IN10	Company policy not to have a PMM	1

Table 6-4 shows the responses of respondents that do not use a PMM. The table was constructed according to the respondents and not the codes, One can see from the responses of the participants that do not use a PMM, each of them had their own

reason why they are not using a PMM. Looking at Table 6-4 there is an indication that participants do not tend to use a PMM, because:

- It is not suitable for the company to have a PMM (Company procedure).
- The project managers tend to use their own methods.
- There isn't a need for a PMM.
- The procedure is dependent on the project that needs to be developed.

This concludes the qualitative results for the interviews conducted. Next the qualitative data of the open questions asked in the questionnaires will be discussed.

6.2 Questionnaires

In this section the open questions asked in the questionnaires will be reported and discussed.

6.2.1 Why did you choose the particular PMM?

Table 6-5 represents the findings of the questionnaire when asked why the particular participant uses a certain PMM. The findings were as follows:

Table 6-5 Why using the particular PMM

Why do you use the particular PMM		
Code	**Respondents**	**# Number**
Company	QU1, QU3, QU4, QU5, QU8, QU10, QU19, QU21, QU33, QU37, QU38, QU39, QU43, QU53, QU55, QU57, QU58, QU59, QU62, QU66, QU74, QU95, QU97, QU98, QU99, QU104, QU111, QU112	28
Manageable	QU2	1
PM Knowledge	QU6, QU7, QU42, QU45, QU51, QU52, QU63, QU64, QU67, QU82, QU87, QU103, QU108	13
PM Certified	QU7, QU12, QU41, QU48, QU51, QU54, QU60, QU61, QU64, QU65	10

Why do you use the particular PMM		
Code	**Respondents**	**# Number**
Ease of use	QU8, QU9, QU11, QU18, QU24, QU84, QU94, QU101, QU113	9
Company Environment	QU13, QU18, QU31, QU36, QU40, QU56, QU68, QU69, QU72, QU80	10
Project Dependent	QU10, QU20, QU32, QU44, QU47, QU50, QU61, QU65, QU67, QU82, QU105	11
Phase Implementation	QU13	1
Practical	QU14	1
Customer Involvement	QU16, QU78, QU85, QU89, QU92	5
Value-Driven	QU17, QU86, QU100	3
Best suits company	QU22, QU29, QU31, QU32, QU40, QU109	6
Change Management	QU23, QU26, QU46, QU47, QU56, QU71	6
Fast	QU25, QU28, QU34, QU67, QU69, QU71, QU75, QU76, QU79, QU81, QU90, QU91, QU92, QU93, QU105, QU107	16
Efficient	QU25, QU28, QU34, QU69, QU70, QU71, QU75, QU76, QU79, QU90, QU93, QU102, QU106, QU107	19
Time Management	QU26, QU34, QU35, QU83, QU89, QU110	6
Experimental	QU27	1
Company Need	QU30	1
Familiarity	QU73	1

Why do you use the particular PMM		
Code	**Respondents**	**# Number**
Cost effective	QU85, QU110	2
Works	QU88	1
Adaptable	QU91, QU100, QU113	3
Communication management	QU78	1
Employee involvement	QU96, QU100	2

The following are the codes used in Table 6-5 on how the individuals responded to why they have chosen the particular PMM:

Company: It is the policy of the company to use the particular project management methodology.

Manageable: The particular project management methodology helps the project manager to manage all activities of the projects.

PM Knowledge: The company has a project manager that has knowledge of the project management methodology used.

PM Certified: The company has a project manager that is certified to run project management methodology.

Ease of use: The set project management methodology is easy to use in the project that the participants undertake.

Company Environment: The set project management methodology suits the company environment.

Project Dependent: The chosen project management methodology is dependent on the type of project the participant undertakes in terms of size, complexity, etc.

Phase Implementation: The participant chose the project management methodology because it helps with the phase implementation.

Practical: The participant chose the set project management methodology because it is more practical.

Customer Involvement: The set project management methodology involves the customer more in the development of the product.

Value-Driven: The set project management methodology is more value-driven.

Best Suits Company: The set project management methodology best suits the company and the needs of the company.

Change Management: The set project management methodology helps the project team with change management that occurs during the project life cycle.

Fast: The project management methodology promotes fast releases and implementation.

Efficient: The set project management methodology is efficient in the product development.

Time Management: The set project management methodology helps with the time management of the projects.

Experimental: The participants chose the set project management methodology on experimental premises.

Company Need: The chosen project management methodology was chosen because there was a need in the company.

Familiarity: The chosen project management methodology was chosen because it was familiar to the employees.

Cost effective: The chosen project management methodology has more value to save costs than not having one.

Works: The set project management methodology was chosen because it works in their company.

Adaptable: The chosen project management methodology was chosen because it is more adaptable to their projects.

Communication management: The particular project management methodology promotes effective communication management.

Employee involvement: The particular project management methodology promotes employee involvement.

This concludes the section for the reasons project managers' use a PMM. The next section consists of why project managers/companies do not use a PMM.

6.2.2 Why do you not use a PMM?

The following table (6-6) reports the findings of why participants do not use a PMM:

Table 6-6 Why not using a PMM

Why don't you use a PMM?		
Codes	**Respondents**	**# Number**
No need	QN1, QN2, QN7, QN8, QN13, QN14, QN23, QN31, QN34, QN35, QN37, QN40, QN45	13
Never Considered	QN3, QN11, QN18, QN19, QN20, QN23, QN24, QN33, QN39	9
Used, but abandoned	QN4, QN15, QN16, QN27, QN28, QN30	6
Never introduced	QN5	1
PM uses basic methods	QN6, QN32	2
Time consuming	QN9, QN10, QN17, QN20, QN26, QN29	6
Considering	QN12, QN44	2
No faith in methodology	QN21, QN25, QN26, QN29, QN33	5
No PMM, but SDM	QN22	1
Complex for employees	QN26, QN35	2
PM lacks knowledge	QN38	1
Costly	QN29	1
Own methods	QN36, QN41, QN42, QN43, QN46	5

The following are the codes used in Table 6-6 on how the individuals responded to why they do not use a PMM:

No need: The participant responded that there is no need in the company for a project management methodology.

Never Considered: The participants responded that they/the company have never considered using a project management methodology.

Used, but abandoned: The participants said that they used to use a project management methodology but in the end they abandoned the methodology.

Never introduced: The participants said that they were never introduced to a project management methodology.

PM uses basic methods: The participants indicated that they do not use a formalized PMM, but do, however, use basic project management methods in their projects.

Time consuming: The participants said that using a project management methodology is very time consuming and when it comes to developing software time cannot be wasted.

Considering: Participants indicated that are not currently using a project management methodology, but they are considering adopting a methodology.

No faith in methodology: The company has no faith in a project management methodology and will thus not use one.

No PMM, but SDM: Participants indicated that the company does not use a formalized project management methodology but rather an SDM (system development methodology).

Complex for employees: Participants said that a project management methodology is too complex for the employees to understand and thus are not using one.

PM lacks knowledge: Participants said that the company does not use a project management methodology because of the project manager's lack of knowledge that led to disaster.

Costly: The cost is higher when using a project management methodology, because of the learning curve and hiring a project manager, thus they do not use one.

Own methods: Project managers use their own methods to the manage projects.

This concludes the section for the reasons why project managers/companies do not use a PMM. The next section consists of a combination between the results of the interviews and results from the questionnaire for using a PMM.

6.2.3 Combining Interview and Questionnaires on using a PMM

In this section a combination of both the interviews and the questionnaires will be given. This is done to see what codes of the interviews and questionnaires for using a PMM overlap. Table 6-7 is the result of this combination:

Table 6-7 Combination of the interview and questionnaires for using a PMM

Interview & Questionnaire for using a PMM		
Codes	Respondents	# Number
Company Standard	IU1, IU2, IU4, IU10, IU13, IU15, IU31, IU40, QU1, QU3, QU4, QU5, QU8, QU10, QU19, QU21, QU33, QU37, QU38, QU39, QU43, QU53, QU55, QU57, QU58, QU59, QU62, QU66, QU74, QU95, QU97, QU98, QU99, QU104, QU111, QU112	36
PM Knowledge	IU7, IU8, IU9, IU10, QU6, QU7, QU42, QU45, QU51, QU52, QU63, QU64, QU67, QU82, QU87, QU103, QU108	17
Ease of Use	IU37, IU48, QU8, QU9, QU11, QU18, QU24, QU84, QU94, QU101, QU113	11
Company Environment	IU1, IU5, IU9, IU32, QU13, QU18, QU31, QU36, QU40, QU56, QU68, QU69, QU72, QU80	14
Suits company	IU20, IU24, IU25, IU29, IU32, IU43, IU45, QU22, QU29, QU31, QU32, QU40, QU109	13
Fast	IU11, IU14, IU17, IU27, IU34, IU44, QU25, QU28, QU34, QU67, QU69,	22

Interview & Questionnaire for using a PMM		
Codes	Respondents	# Number
	QU71, QU75, QU76, QU79, QU81, QU90, QU91, QU92, QU93, QU105, QU107	
Efficient	QU25, QU28, QU34, QU69, QU70, QU71, QU75, QU76, QU79, QU90, QU93, QU102, QU106, QU107	14
Adaptable	IU25, IU48, QU91, QU100, QU113	5
Change Management	IU33, IU34, IU41, IU43, IU45, QU23, QU26, QU46, QU47, QU56, QU71	11

Table 6-7 shows that there are nine distinct reasons from both the interviews and questionnaire participants in regard to using a PMM. Participants agree that the reason for them using a PMM is:

- **Company:** It is the policy of the company to use the particular project management methodology
- **PM Knowledge:** The company has a project manager that has knowledge of the project management methodology used.
- **Ease of use:** The project management methodology is easy to use in the project that the participants undertake.
- **Company Environment:** The project management methodology suits the company environment
- **Best Suits Company**: The project management methodology best suits the company's projects and the needs of the company.
- **Fast:** The project management methodology promotes fast releases and implementation.
- **Efficient:** The project management methodology is efficient in the product development.
- **Change Management:** The project management methodology helps the project team with change management that occurs during the project life cycle.

- **Adaptable**: The chosen project management methodology was chosen because it is more adaptable to their projects.

This concludes the section for the reasons why project managers/companies uses a PMM for both the interviews and questionnaires. The next section consist of a combination between the results of the interviews and results from the questionnaire for not using a PMM

6.2.4 Combining Interview and Questionnaires on not using a PMM

In this section a combination of both the interviews and the questionnaires will be given. This is done to see what codes of the interviews and questionnaires for not using a PMM overlap. Table 6-8 is the result of this combination:

Table 6-8 Combining interview and questionnaires on not using a PMM

Interview & Questionnaire for not using a PMM		
Codes	**Respondents**	**# Number**
No need	IN6, QN1, QN2, QN7, QN8, QN126, QN14, QN23, QN28, QN34, QN35, QN37, QN40, QN45	14
Own methods	IN2, IN5, IN8, IN9, QN36, QN41, QN42, QN53, QN46	9

Table 6-8 shows that there are two distinct reasons from both the interviews and questionnaire in regard to not using a PMM. Participants believe that there is no need for a PMM in their company and if they use methods it will be their own. This concludes that qualitative results confirm the quantitative results of this study. This helped to understand the data from both the use and none use of a PMM in the qualitative data.

This concludes the qualitative data for the open questions asked in the questionnaires. In the next chapter the conclusion of this study will be given.

CHAPTER 7
CONCLUSION

In this chapter the conclusion and discussion of the results, which were presented in chapter 5 and chapter 6 will be given. This chapter will start by giving the aims and objectives of this study to verify what was done and for what reason. Thereafter each aim's and objective's results will be discussed and concluded. Contributions, limitations and future work will also be discussed later in this chapter.

7.1 Aims and objectives

The main aim of this study was to research the use and effectiveness of project management methodologies in mobile application development. In order to achieve this aim the following objectives were addressed:

1. Determine the current status of mobile application development in South Africa.
2. Determine the success of mobile application development in South Africa.
3. Determine the use of project management methodologies (if any) in mobile application development.
4. If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.
5. If project management methodologies are used, determine how intensely, widely and strictly they are used.
6. If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.
7. If project management methodologies are used, how effectively are they used?

7.2 Results and discussion

In this section of the chapter the discussion of the results will be given to indicate how the aims and objectives of this study were met. This is done to give a broader insightful view about the study and the purpose of what was accomplished.

7.2.1 Determine the current status of mobile application development in South Africa.

Firstly, looking at the status of MAD in South Africa, it is clear that the majority of the respondents, 75.3%, develop mobile applications. This a positive indicator that mobile developing companies are growing.

7.2.2 Determine the success of mobile application development in South Africa.

Looking at the success of MAD in South-Africa one can see that developing teams reported a positive mean of firstly, the process success of 3.8 out of 5. Secondly, the product success had a positive mean average indication of 3.95 out of 5. The majority of the participants were satisfied with their last project's process and product success. Lastly, looking at the outcome of their last project, the majority, 90.4%, indicated that the last project they worked on was completed, implemented and is currently still in use. Taking all the above-mentioned aspects into account, one can see that MAD in South Africa is successful.

7.2.3 Determine the use of project management methodologies (if any) in mobile application development.

When looking at the number of PMMs the participants used and the type that they used one can see that companies tend to use only one PMM at a time. Out of all four major PMMs, Agile was the most used PMM. Considering MAD projects and what was found in the literature about meeting market demands and rapid releases, one can make the connection to Agile being used for MAD projects in general. Going back to the literature, the agile PMM fits the profile for MAD projects by being more flexible, having continuous designs, delivering more features, etc. (Larson & Gray, 2011:585). When developing MAD projects, project managers need to consider using the agile PMM and not traditional PMMs. This will result in projects having more structured processes, but not being as formal as traditional PMMs.

7.2.4 If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.

As 29.5% of the participants did not use a PMM it raises the question: “Why not?” The participants said that to their knowledge the company either never considered using a PMM or they considered using a PMM, but in the end they decided against using one. This gives rise to another question: “What could be the reasons for not using a PMM?” Looking back at the responses there is a very clear indication that:

- There is no need inside the company for using a PMM.
- The participants tend to use their own methods when it comes to MAD, because there is no specific PMM for developing MAD.
- There is a lack of staff experience to effectively drive and implement a PMM.
- The new system development with PMM is not currently compatible with the company’s legacy systems.
- There is a lack of support. This can be either from the company’s side to the employees/project manager or from the project manager to the project team. This confirms the literature in the problem statement of this study.
- The learning curve of the using a PMM is too long and will take up time that the company does not have.
- The financial investment that the company needs to make is far too long. This requires the company to hire and/or train a project manager.
- The company’s IS department is uncertain of what the benefits are for adopting a PMM and that there are no clear objectives for adopting a PMM.

Observing all these reasons for not using a PMM it can be that participants only use APMM for MAD, which are small projects. The descriptive statistics of the sample confirm that the majority of the project teams, project budget and the projects were small. This is typical of MAD. In this context it is clear that the participants would not use a heavy weight methodology like PMBOK, PRINCE2 and COBIT for small projects. These heavy weight PMM cater for large complex projects.

The most important reasons obtained from the qualitative data are:

- **Lack of staff experience**: There is a lack of staff experience. Because of the projects that were small there is not enough staff experience to take on a heavy weight methodology, thus not needing a traditional PMM for their projects.
- **No need**: The company does not have a need to adopt a PMM, because their current methods are sufficient.

Looking at the PM activities performed by the participants not using a PMM, it is clear that:

- The participants do estimate the time, money and people needed for each project they undertake.
- The participants agreed that communication is an important aspect in regards to the transparency to all levels.
- The participants still hold regular meetings with their clients.
- That the participants do not understand the background and history of the projects they undertake.
- They do not have clear project management roles within the company.

7.2.5 If project management methodologies are used, determine how intensely, widely and strictly they are used.

All three these factors (intensely, widely and strictly) had a high indication with each having a mean of above 7 out of 10. Participants who use a PMM indicated that they use their PMMs intensely, widely and strictly. When looking at the participants' indication of their product and process success, it would appear that if the participants apply these factors, the greater the favourable outcome would be on their product development as well as on the process success.

7.2.6 If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.

Choosing a PMM is not an easy task. There are various factors that need to be kept in mind when choosing a PMM. In this study one wanted to understand why the participants chose their particular PMM. The reasons that were very clear for choosing a certain PMM were:

- Companies/Project managers choose a PMM based on the factors that a PMM is fast, flexible, efficient, adaptable, and easy to use.
- Companies/Project managers choose a PMM, because it helps with time, budget and change management of each project.
- Companies/Project managers choose a PMM based on what types of project they take on. This is dependent on the complexity, size, cost, etc.
- Companies choose a PMM based on their project manager's knowledge/qualification regarding a certain PMM.
- Project managers do not always have a say in the matter, because companies have a standardized PMM that they use. The PMM is chosen by the company and is enforced on its projects.

One can see that all these factors are in the end important when taking on a certain project. This does not say that one aspect is more important than another, rather that it depends on the company to choose what is important to it or not, but to make an informed decision regarding the above-mentioned reasons. Choosing a PMM for the success of each project a company takes on should not be done lightly.

Looking at the general PM activities used one can see that if the participants use a PMM, then their activities on their projects can be divided into four groups, namely:

- **Activities regarding choices**: This includes what PMM the participants will be using in their projects.
- **Project Planning**: This includes the planning that needs to be done on projects.
- **General PM Activities**: This involves all the general PM activities that needs to be applied to each project.
- **Activities regarding time**: This includes the time management for each project.

7.2.7 If project management methodologies are used, how effectively are they used?

Looking at how effectively the participants use their particular PMM one can see that developing teams are more successful in their processes and product development than those who do not use it effectively. As previously mentioned, if the participants

used their PMM more widely, strictly and intensely the greater their chances of product and process success. This indicates that better results will be achieved from using a PMM than those who do not choose to use a PMM.

7.3 Contributions

Looking at the contributions that this study has made and can make, there are two aspects that can be identified, both to the industry and to academics. Firstly, the contributions made to the industry will be discussed followed by the study's contribution to academics.

7.3.1 Industry

There is a clear indication in the results discussed above that project managers need to use a PMM when developing mobile applications. Most of the participants use APMM when developing MAD which leads to more successful development. It is recommended that when developing MAD PM/companies should use APMM. For bigger projects, one of the other PMMs (PMBOK, PRINCE2 and COBIT) should be used.

7.3.2 Academics

For this study a comprehensive search was done regarding PMM with MAD. There are, however, system development methodologies with MAD, but no results of PMM with MAD. This would be a first empirical study with a combination of these two concepts.

7.4 Limitations

In respect of the limitations of this study there are a couple of aspects to be considered. Firstly, there is the aspect of the participants involved in this study. There was a low response rate that could be changed to get more people involved. The second is the geographical aspect of the study. This study only focused on PMM and MAD within South Africa. To get a broader perspective of this study, one could broaden the ratio to other countries and then globally.

7.5 Future work

The future work for this study includes:

- To develop a PMM that best suits the characteristics of a MAD project in the industry because it is clear from this study that participants uses APMM and not heavy weight PMMs. Also from this study it is concluded that the participants use their own methods when it comes to the managing of MAD, thus resulting the need for a PMM in MAD.
- To do a wider and more comprehensive study. This includes looking at involving more participants in the study and the geographical location.

In this chapter the conclusion and discussion of the results, which were mentioned in Chapter 6 were given. This chapter started by stating the aims and objectives of this study to verify what was carried out and for what reason. Thereafter each aim's and objective's results were discussed and conclusions were drawn. Contributions, limitations and future work were also discussed in this chapter.

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

February 2015

Dear Respondent,

I am a master's student in the Information Technology and Computer Science Department at the North-West University and I am conducting a study to determine use and effectiveness of project management methodologies in mobile application development in South-Africa. The objective of this research project is to:

- Determine the current status of mobile application development in South-Africa.
- Determine the success of mobile application development in South-Africa.
- Determine the use of project management methodologies (if any) in mobile application development.
- If no project management methodology is used, determine how control and management of projects take place; understand the reasons why project management methodologies are not used.
- If project management methodologies are used, determine how intensely, widely and strictly they are used.
- If project management methodologies are used, determine how activities are performed; understand the reasons why the specific project management methodology was chosen.
- If project management methodologies are used, how effectively are they used?

Enclosed with this letter is a brief questionnaire that asks a variety of questions about mobile application technology and software development in general, secondly about project management methodologies and the projects that you are working on at the moment. I am asking you to look over the questionnaire and, if you choose to do so, complete the questionnaire and send it back to me via email.

If you choose to participate, please do not write your name on the questionnaire. I do not need to know who you are and no one will know whether you participated in this study. Your responses will not be identified with you personally, nor will anyone be able to determine which company you work for. Nothing you say on the questionnaire will in any way influence your present or future employment with your company.

I hope you will take a few minutes to complete this questionnaire. Without the help of people like you, research on employees could not be conducted. Your participation is voluntary and there is no penalty if you do not participate.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me at (011) 299-2531 or at 082 85 333 75. My email address is 22174109@nwu.ac.za.

Sincerely,

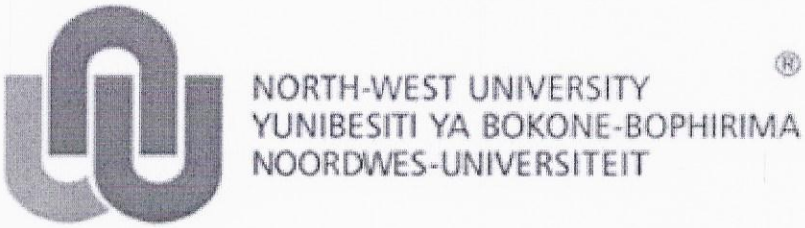
Estiane de Lange
Masters student
Department of Information Technology and Computer Science

Project management methodologies with Mobile application development

The purpose of this study is to examine the use and effectiveness of project management methodologies in mobile application development.

Your responses will not be identified with you personally, nor will anyone be able to determine which company you work for. Nothing you say on the questionnaire will in any way influence your present or future employment with your company.I hope you will take a few minutes to complete this questionnaire. Without the help of people like you, research on employees could not be conducted. Your participation is voluntary and there is no penalty if you do not participate.

* Required



General

1. **Age** *

.....

2. **Gender** *
   Mark only one oval.

   - ◯ Male
   - ◯ Female

3. **Which markets does your company operate in?** *
   Check all that apply.

   - ☐ IT
   - ☐ Banking
   - ☐ Agriculture
   - ☐ Education
   - ☐ Manufacturing
   - ☐ Insurance

4. **Race** *
Mark only one oval.

- ◯ Black
- ◯ White
- ◯ Asian
- ◯ Indian
- ◯ Other

5. **Job Title** *

.....

.....

.....

.....

.....

6. **Exprience** *
(Years in the industry concerning mobile application development)
Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10+

7. **Qualification** *
(Top 3)

.....

.....

.....

.....

.....

COMPANY

8. **Size of the company** *
   In terms of People
   Mark only one oval.

   - ◯ 10-20
   - ◯ 20-30
   - ◯ 30-40
   - ◯ 40-50
   - ◯ 50-60
   - ◯ 60-70
   - ◯ 70-80
   - ◯ 80-90
   - ◯ 90-100
   - ◯ 100+

9. **Who is your target audience?** *
   Check all that apply.

   - ☐ Business
   - ☐ Individual
   - ☐ Enterprise

10. **Do you develop mobile application software?** *
    Mark only one oval.

    - ◯ Yes
    - ◯ No

11. **If yes, please state the percentage (%) of the software development you spent on developing mobile software**

    .....

PROJECTS

(Last development project worked on)

12. **Last project worked on** *
    (Please provide a very brief description)

    .....

    .....

    .....

    .....

    .....

13. **Size of project** *
Mark only one oval.

- ◯ Very Small
- ◯ Small
- ◯ Medium
- ◯ Large
- ◯ Very Large

14. **Who is your target audience?** *
(In terms of platforms) (you can choose more than one)
Check all that apply.

- ☐ Android
- ☐ iOS
- ☐ Blackberry
- ☐ Windows Mobile
- ☐ Tizen

15. **Total Buget** *
For the current project

.....

16. **How many members involved** *
Mark only one oval.

- ◯ 5-10
- ◯ 10-15
- ◯ 15-20
- ◯ 20-25
- ◯ 25+

PROJECT

The next section concerns mobile application development

17. **Which of the following best describes the outcome of the last mobile application development project you were involved with?** *
Mark only one oval.

- ◯ The project was cancelled/terminated before completion
- ◯ The project was compelled but not implemented
- ◯ The project was completed and implemented, but not in use anymore
- ◯ The project was completed and implemented, and is in use

To what extent do you agree with the following statements about the last project you were involved with concerning

mobile application development?

18. **The project was completed on schedule** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

19. **The project was completed within the budget** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

20. **The developed system satisfied all the stated requirements** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

21. **The speed of developing the project was high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

22. **The productivity of developers involved with the project was high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

23. **The cost of the project is low when compared to the size and complexity of the system developed** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

24. **The project achieved its goals** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

25. **Overall, the project represents excellent work** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

26. **Overall, the project was a success** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

Product Success

27. **The functionality of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

28. **The reliability of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

29. **The maintainability of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

30. **The portability of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

31. **The efficiency of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

32. **The usability of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

33. **The developed system meets user needs** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

34. **The documentation of the developed system is good** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

35. **Overall the quality of the developed system is high** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

36. **Overall, the users are satisfied with the developed system** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

37. **Overall, the developed system is a success** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

Project management methodologies

(used in the last mobile application development project worked on)

38. **Do you use a project management methodology?** *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 68.*

Using a Project management methodology

39. **How many project management methodologies do you use?** *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3

40. **What project management methodologies do you use?** *

Check all that apply.

- ☐ AGILE
- ☐ PMBOK
- ☐ PRINCE2
- ☐ RUP
- ☐ COBIT

41. **Why did you choose the particular project management methodology?** *

.....

.....

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.....

.....

Rate the following on a scale from 1 to 10

42. ***How intense do you use the project management methodology?*** *
Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

43. **How widely do you use the project management methodology in the project? (# of people in the company)** *
Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

44. **How strictly are you regarding the use of the project management methodology?** *
Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

To what extent do you agree with the following statements regarding project management methodologies?

(the last mobile application development project worked on)

45. **We always complete a project plan for our projects** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

46. **All our projects use product based planning technique** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

47. **All our projects follow an effective project initiation or start-up stage** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

48. **We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

49. **It is important to make project communication transparent at all levels** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

50. **All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

51. **All our projects follow a calendar of core project plan with intended start and finish dates** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

52. **All our projects have defined project management roles** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

53. **All our projects follow effective cost management** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

54. **We have sometimes resolved management, operational and technical issues during the course of projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

55. **A project support office is set up to assist project managers with their work like administrative work needed, keeping files and arranging meetings especially during large projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

56. **Effective project procurement management is an important process** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

57. **All our projects have a clear focus on where to prioritize and place project resources** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

58. **We often use the same project management method for similar projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

59. **We understand the background or history of the projects we undertake** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

60. **We estimate the time, money and people we need for the job** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

61. **We hold regular meetings with our clients** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

62. **We carry out a project closure process after completion** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

63. **Our project approach requires decision making and phasing in managing the project** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

64. **The scale of the projects influences the methodology to be used** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

65. **our methodology removes the causes of failure in our projects** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

66. **The use of methodologies influences the entire project life cycle from conception to project closure** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

67. **The current economic downturn has affected our use of project methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

Skip to "END OF QUESTIONNAIRE."

Not using a Methodology

68. **Why don't you use a methodology?** *

.....

.....

.....

.....

.....

69. **Have you ever considered using a methodology?**
Mark only one oval.

◯ Yes
◯ No

70. **Which of the following best describes the situation in your IS department?** *
Mark only one oval.

◯ Your IS department had never consider using project management methodologies
◯ Your IS department had consider using project management methodologies, but decided against it.
◯ Your IS department did use project management methodologies in the pas, but abandoned it.

To what extent do you agree with the following statements in terms of what the reasons are for not using a methodology?

71. **The profile of development projects in our IS department doesn't require the use of project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

72. **Project management methodologies are too complex or hard to use** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

73. **The current project management methodologies practice in our IS department is adequate** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

74. **The experience of the system of the developers in our IS department reduces the need for project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

75. **The benefits of project management methodologies use are long-term, whereas costs are incurred short term** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

76. **There is a lack of experienced staff in our IS department who can effectively use project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

77. **New system development with systems development methods are not compatible with legacy systems** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

78. **Our IS department lacks a suitable environment to support project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

79. **In our IS department there is a lack of management support for the use of project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

80. **The learning curve of project management methodologies is very long** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

81. **The financial investment in project management methodologies is too long** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

82. **In our IS department there is a lot of uncertainty over the benefits of adopting project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

83. **In our IS department there is no clear objectives for adopting project management methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

To what extent do you agree with the following statements regarding project management methodologies?

(the last mobile application development project worked on)

84. **We always complete a project plan for our projects** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

85. **All our projects use product based planning technique** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

86. **We determine our projects justification and scope** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

87. **All our projects follow an effective project initiation or start-up stage** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

88. **We carry out stage reviews on all our projects by checking results so far and reacting to exceptional situations** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

89. **It is important to make project communication transparent at all levels** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

90. **All our projects have a phase where we build the physical project deliverables and present them to our customers for sign off.** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

91. **We have sometimes resolved management, operational and technical issues during the course of projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

92. **All our projects follow a calendar of core project plan with intended start and finish dates** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

93. **All our projects have defined project management roles** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

94. **All our projects follow effective cost management** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

95. **Our Clients, Suppliers and Users of the projects are organized and coordinated so that the required outcome is within budget, on time and to specification** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

96. **A project support office is set up to assist project managers with their work like administrative work needed, keeping files and arranging meetings especially during large projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

97. **Effective project procurement management is an important process** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

98. **All our projects have a clear focus on where to prioritize and place project resources** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

99. **We often use the same project management method for similar projects** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

100. **We understand the background or history of the projects we undertake** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

101. **We estimate the time, money and people we need for the job** *

Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

102. **We hold regular meetings with our clients** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

103. **We carry out a project closure process after completion** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

104. **Our project approach requires decision making and phasing in managing the project** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

105. **The scale of the projects influences the methodology to be used** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

106. **Our methodology removes the causes of failure in our projects** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

107. **The use of methodologies influences the entire project life cycle from conception to project closure** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

108. **The current economic downturn has affected our use of project methodologies** *
Mark only one oval.

	1	2	3	4	5	
Totally Disagree	◯	◯	◯	◯	◯	Totally Agree

Skip to "END OF QUESTIONNAIRE."

END OF QUESTIONNAIRE

Thank you for your participation in this questionnaire. It is very much appreciated.

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