A systems development methodology for developing location based games

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All The Glory To God

(Soli Deo Gloria)

Abstract

Rapid expansion and development in the modern mobile technology market has created an opportunity for the use of location-based technologies in games. Because of this fast expanding market and new technology, it is important to be aware of the implications this expansive technology could have for computer security. Furthermore, this has also led to a lack of systems development methodologies (SDM) suitable for the development of location-based games.

In this study an attempt will first be made to measure the impact of location-based technologies and games on the security awareness of first- to fourth-year computer science university students. A questionnaire, posted on the web, and completed by computer science students from different year groups, was used to collect the data. The major results are the following: there is a difference in the security awareness of computer science students who use and play location-based services, technologies and games and those who do not. It was also determined that the computer science students are cautiously aware of security implications although they do not take preventative measures.

Secondly, a framework that can be used to evaluate the suitability of SDMs for the development of location-based games will also be introduced in this study. A list of aspects that need to be addressed in the development process for location-based games was identified. One of the aspects is security and privacy. By incorporating this aspect into the development process of location-based games, an emphasis on secure development is addressed based on the security awareness results. The identified aspects were incorporated in a survey to rank their importance with regard to the development of location-based games. SDMs most often used for developing mobile applications and mobile and traditional games were identified and evaluated using the framework developed in this study. The results of the evaluation indicated that none of the chosen SDMs is perfectly suited for the development of location-based games.

Lastly, a newly developed SDM to aid in the development process of location-based games, called the Developmental Methodology for Location-Based Games (DMLBG) will be introduced. The DMLBG was developed based on the results obtained from the framework. Four different indie game development groups were asked to test the DMLBG. During this test, the four indie games developer groups used the DMLBG extensively while developing a location-based game to test the feasibility of the SDM. The results showed that the SDM did aid all four of the teams to develop a successful location-based game. The teams documented the development process and gave critical feedback on their experiences. This

feedback was used to revise and improve the SDM. The DMLBG addressed the lack of an SDM that is suitable for the development of location-based games.

Keywords: location-based services, location-based technologies, location-based games, systems development methodologies, security awareness.

Opsomming

Die vinnige uitbreiding en ontwikkeling van die mark in moderne mobiele tegnologie het ’n geleentheid geskep vir die gebruik van plekgebaseerde tegnologieë in speletjies. Weens hierdie snel groeiende mark en nuwe tegnologie is dit belangrik om bewus te wees van die implikasies wat hierdie ontluikende tegnologie vir rekenaarsekuriteit kan inhou. Daarby het dit ook gelei tot ’n gebrek aan stelselontwikkelingsmetodologieë (SOM) wat geskik is vir die ontwikkeling van plekgebaseerde speletjies.

In hierdie studie sal daar eerstens gepoog word om die impak van plekgebaseerde tegnologieë en speletjies op die sekuriteitsbewustheid van eerste- tot vierde-jaaruniversiteitstudente in rekenaarwetenskap te meet. ’n Vraelys wat op die web geplaas is en wat deur studente in rekenaarwetenskap uit verskillende jaargroepe voltooi is, is gebruik om data in te samel. Die hoofresultate is soos volg: daar is ’n verskil in die sekuriteitsbewustheid van studente in rekenaarwetenskap wat plekgebaseerde dienste, tegnologieë en speletjies gebruik en speel en diegene wat nie van hierdie dienste gebruik maak of hierdie speletjies speel nie. Daar is ook vasgestel dat die rekenaarwetenskap-studente versigtig is wat betref die veiligheidsimplikasies, al pas hulle nie voorkomende maatreëls toe nie.

Tweedens sal daar in hierdie studie ook ’n raamwerk bekendgestel word wat aangewend kan word om die geskiktheid van SOM’e vir die ontwikkeling van plekgebaseerde speletjies te evalueer. ’n Lys aspekte wat aangespreek moet word in die ontwikkelingsproses vir plekgebaseerde speletjies is geïdentifiseer. Een van die aspekte is sekuriteit en privaatheid. Deur hierdie aspek by die ontwikkelingsproses van plekgebaseerde speletjies te inkorporeer, word klem op veilige ontwikkeling aangespreek, gebaseer op die veiligheids-bewustheidsresultate. Die geïdentifiseerde aspekte is in ’n opname geïnkorporeer om hulle belangrikheid met betrekking tot die ontwikkeling van plekgebaseerde speletjies op ’n ranglys te plaas. SOM’e wat die meeste gebruik is vir die ontwikkeling van mobiele toepassings en mobiele en tradisionele speletjies is geïdentifiseer en geëvalueer aan die hand van die raamwerk wat in hierdie studie ontwikkel is. Die resultate van die evaluering het aangedui dat nie een van die gekose SOM’e ideaal geskik is vir die ontwikkeling van plekgebaseerde speletjies nie.

Laastens sal daar in hierdie studie ’n nuut ontwikkelde SOM bekendgestel word wat kan help in die ontwikkelingsproses van plekgebaseerde speletjies, en wat die ontwikkelings-metodologie vir plekgebaseerde speletjies (OMPBS) genoem word. Die OMPBS is ontwikkel na aanleiding van die resultate wat verkry is van die raamwerk. Vier verskillende

onafhanklike speletjie-ontwikkelingsgroepe is versoek om die OMPBS te toets. Tydens hierdie toets het die vier onafhanklike speletjie-ontwikkelingsgroepe die OMPBS ekstensief gebruik terwyl hulle ’n plekgebaseerde speletjie ontwikkel het om die uitvoerbaarheid van die SOM te toets. Die resultate het getoon dat die SOM al vier die spanne gehelp het om ’n geslaagde plekgebaseerde speletjie te ontwikkel. Die spanne het die ontwikkelingsproses gedokumenteer en terugvoering omtrent hulle ervarings gegee. Hierdie terugvoering is gebruik om die SOM te hersien en te verbeter. Die OMPBS het die gebrek aan ’n SOM wat geskik is vir die ontwikkeling van plekgebaseerde speletjies aangespreek.

Sleutelwoorde: plekgebaseerde dienste, plekgebaseerde tegnologieë, plekgebaseerde speletjies, stelselontwikkelingsmetodologieë, sekuriteitsbewustheid

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List of Abbreviations

AI – Artificial intelligence

AR – Augmented reality

BBM – Blackberry messenger

COCOMO – The constructive cost model

DMLBG – Developmental Methodology for Location-Based Games

E-mail – Electronic mail

GPS – Global positioning system

ID – Identification number

Indie games developers – independent games developers

MDA Framework – Mechanics, Dynamics and Aesthetics Framework

MASAM – Mobile Application Software Based on Agile Methodology

MMS – Multimedia messaging service

PS2 – PlayStation 2

PS3 – PlayStation 3

PSP – PlayStation Portable

RAD with DSDM Atern – Rapid Application Development with Dynamic Systems Development Method Atern

SDLC - Systems Development Life Cycle

SDM – Systems development methodology

SMS – Short message service

Ubigames – Ubiquitous games

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Chapter 1 Introduction

1.1. Motivation for study

Mobile devices have overtaken desktops and laptops in everyday use and have become an important tool in day-to-day activities (Arunkumar *et al.*, 2015). Based on this growth of the mobile market the aim of this study will be to focus on various mobile environments. More specifically the study aims to address security awareness of location-based services, technologies and games, as well as to analyse systems development methodologies (SDM) for their suitability to aid in location-based game development and to develop an SDM that is more suitable for location-based games.

Based on a study conducted in 2010 mobile location-based services would have accumulated more than $12.7 billion by the year 2014 (Juniper Research, 2010). In a more recent study, according to a leading telecom publisher, the estimated value of location-based services will reach $43.3 billion by the year 2019. This indicates the growth of the location-based services (Cellular News, 2014; Juniper Research, 2014). Mobile devices have grown in order to be able to continuously connect to different services, such as Wi-Fi, cellular networks, the Internet and location-based services (Arunkumar *et al.*, 2015). Due to the rapid evolution of mobile devices, location-based services were made possible (Li *et al.*, 2014a). Mobile devices that are equipped with improved location-based technologies increase the use of location-based services (Patel & Palomar, 2014). This increased use, as well as the explosive growth of mobile devices that implement location-based technology, wireless communication and mobile databases has led to location-based applications (Mokbel, 2007). This may lead to security vulnerabilities of which the users of these technologies should be made aware (Arunkumar *et al.*, 2015).

Furthermore, ubiquitous games (ubigames) gave birth to some game genres of their own (Buzeto *et al.*, 2014). The best known of these game genres is location-based games (Buzeto *et al.*, 2014). Location-based games make extensive use of location-based services as part of the gaming mechanism to immerse the player in the gaming world (Venselaar, 2014). In recent years a great number of location-based games has been developed (Avouris & Yiannoutsou, 2012). This is due to the widespread use of mobile devices that have the capability of determining the players' locations (Ejsing-Duun, 2011; Venselaar, 2014). A few examples of these games that are available on mobile phones are: PacManhattan (New York University's Interactive Telecommunications graduate program),

BotFighters (It's Alive Mobile Games AB), Geocaching (Groundspeak Inc.), CySMN (Mixed Reality lab, University of Nottingham), Tiny Tycoons (The Tap Lab, Inc.) and Feeding Yoshi (Glasgow University's Equator group in partnership with the University of Nottingham and the University of Lincoln) (Ejsing-Duun, 2011; Venselaar, 2014). The most recent and biggest success story of a location-based game is Pokémon GO (Nintendo) (Allan, 2016; Price, 2016). Pokémon GO, released in 2016 was so successful that the release of the game caused Nintendo's shares to increase by 25%, amounting to an increase of around $9 billion in share price (Hussain, 2016; Makuch, 2016; Price, 2016). The game also overtook the users of Twitter and Tinder on the respective mobile applications stores (Allan, 2016; Price, 2016). All these games use location-based services to determine the location of the players in the game. Some of the players might not even realise that they are using location-based services or be aware of the security risks involved in playing location-based games.

One of the major problems with using location-based technology, location-based services and location-based games is the unauthorised disclosure of the user's location (Elkhodr *et al.*, 2012). Researchers, users, service providers and government organisations have been aware of this problem for a while (Elkhodr *et al.*, 2012). Research has been conducted in the field of location-based technology, services, games and security. Most of the security research focuses on the different types of attack (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014), defence mechanisms (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014) and harm that can befall a user (Bettini *et al.*, 2009; Krumm, 2009; Fusco *et al.*, 2010; Peddinti *et al.*, 2011; Sweatt *et al.*, 2014). To the best of the researcher's knowledge there are no studies that measure whether or not the use of these technologies, services and games increases the security awareness of a user.

Based on the growing interest in location-based services, technologies and games as well as the harm that can befall a user, it is important to determine the security awareness of the users. It is also important to determine whether or not the use of location-based services, technologies and games increases the awareness of the users.

Finally, the security aspects and security awareness should be incorporated into the development process of location-based applications and games.

This study will also focus on the development process of location-based games due to the fact that the gaming industry is expected to reach 100 billion dollars worldwide by the year 2018 (Game Industry Biz, 2015). This was based on research conducted by a research company, DFC Intelligence (DFC Intelligence, 2015; Game Industry Biz, 2015). Furthermore, the company found that the mobile gaming market (including location-based games) will

grow from 10 billion dollars in 2013 to 29 billion dollars in 2018 (DFC Intelligence, 2015; Game Industry Biz, 2015). Mobile games will account for almost 30% of the total revenue generated by the gaming industry (DFC Intelligence, 2015; Game Industry Biz, 2015). This is important to note as it indicates that the mobile gaming industry is growing rapidly.

Despite the rapid expansion of the gaming industry's expenses and complexity there is a need for SDMs to enhance the productivity in respect of quality, time and cost (Reyno & Cubel, 2008). Furthermore, the complex nature of the development process of games adds to the need for a specialised SDM (Callele *et al.*, 2005). The reason for the absence of SDMs in the gaming industry is that at the beginning, games were developed by one person and did not need an entire SDM (Keith, 2010:4-5). As the gaming industry expanded and the technology became more complex, the lone programmer became reliant on large teams and other specialists (Keith, 2010:6-7). To reduce the risk of not completing the game due to the growing need of game development, most companies adopted the Systems Development Life Cycle (SDLC), also known as the Waterfall model (Keith, 2010:6-8). When this study was conducted, most games developers rely on *ad hoc* development, agile development, component-based development and software product lines (Reyno & Cubel, 2008; Keith, 2010).

Although the gaming industry shares the same methodologies as traditional software engineering as mentioned above, there is still a vast majority of problems that the gaming industry faces (Al-azawi *et al.*, 2014). The first of these problems is that the gaming companies adopt a poor SDM or an SDM that does not fit the company (Kanode & Haddad, 2009). Subsequently, in a study conducted by Al-azawi *et al*. (2014), a list of problems with the current game development methodologies (also including methodologies from traditional software engineering that might be used) includes: Schedule problems, Crunch time problems, Scope and feature creep, Technology problems, Documentation problems, Collaboration and team management problems, Training problems and Linear process problems. There is a lack of SDMs that specifically address all the needs of the game development process, more specifically to the best of the researcher's knowledge there is a lack of SDMs for the development of location-based games.

This lack of SDMs to aid in the development of games can potentially have a negative impact on the game development companies. The reason for this is that the effort in creating a game is so great that failure of the game could mean the end of the gaming company (Keith, 2010:7-10). Furthermore, this means that the gaming company would need to only publish major title releases to just break even (Keith, 2010:7-10). For the gaming market to

survive, the same needs to happen as in other markets or industries, such as looking to new development methodologies that can better aid in the development process of games, to better mitigate risk by using SDMs and finding different ways for people to work together on game development projects (Keith, 2010:10-12). Furthermore, ubigames make use of different and usually the latest hardware components that can be used to immerse the player in the gaming world. The result is that the software development of ubigames lags behind the hardware development (Nicklas *et al.*, 2001). This also leads to the lack of SDMs for these types of game. There are various types of ubigames and to be able to determine whether or not an SDM can aid in their development, one should start by focusing on a single type of these games. Therefore, this study will focus on the development of an SDM that is specifically suited for the development of location-based games. The reason for choosing to develop an SDM for location-based games is that according to the researcher's knowledge there is no SDM that is perfectly suited to aid in the development of location-based games. To be able to achieve this, this study will present the different phases, artefacts and data gathered that were used to develop the SDM.

1.2. Aims and Objectives of study

The primary aim of this study is to develop and test an SDM that is better suited to aid in the development of location-based games.

To achieve this aim, the following sub-objectives will need to be achieved:

1. Determine the effect of using mobile location-based technologies and mobile location-based services on security awareness.
2. Determine the effect of playing location-based games on security awareness.
3. Define unique aspects that need to be addressed in the development process of location-based game development to determine the requirements for a new SDM.
4. Test the aspects in a survey to gather information, from the gaming industry, to determine how important each aspect is and whether or not the study has neglected to incorporate any aspects.
5. Develop a framework based on the feedback from the industry that can be used to analyse SDMs to determine their suitability to aid in the development of location-based games
6. Demonstrate the use of the framework by analysing a few selected SDMs to determine their suitability for the development of location-based games.

7. Develop an SDM that can aid in the development of location-based games; the development will be based on the analysis that will be done in the previous sub-objective.
8. Allow independent (indie) games developers to use the SDM to develop location-based games in order to evaluate the SDM.
9. Use the developers' and project managers' feedback to improve and refine the SDM.

1.3. Key concepts in study

A list of key concepts on which this study is based is as follows:

1. Location-based technologies: Location-based technology is a group of technologies that have the ability to communicate physical location (Lemos, 2008). In general, the hardware that are grouped together to achieve tracking of physical location are digital devices (smartphone and tablet), sensors and digital wireless networks (Global positioning system, Wi-Fi and Bluetooth) (Lemos, 2008). This group of hardware is also known as location-based technology. Location-based technology is usually integrated into mobile hand-held devices, such as smartphones (Kushwaha & Kushwaha, 2011).
2. Location-based services: Mobile location-based services use mobile location-based technology to generate and exchange information about the location of the mobile device (Park *et al.*, 2005; Lemos, 2008; Kushwaha & Kushwaha, 2011). Moreover, a location-based service is an information service that is accessible to mobile devices and utilises the mobile network of the mobile device to determine the location of the mobile device (Kushwaha & Kushwaha, 2011).
3. Location-based games: Location-based games can be described as games that incorporate the player's location in the real world as a gaming mechanism (Venselaar, 2014). The player's position in the real world is interpreted as input that influences the progress of the gaming world (Venselaar, 2014).
4. Systems development methodology (SDM): According to Avison and Fitzgerald (2006:24), an SDM can be defined as the totality of a systems development approach. To elaborate: an SDM is a set of recommended rules, processes and/or steps that needs to be followed. Each of these forms part of the total development process that is usually governed by an underlying philosophy that supports, justifies and incorporates coherent context for a specific development project (Avison & Fitzgerald, 2006:597-603).

1.4. Research Design

1.4.1. Research Paradigm

The research paradigm that will be used in this study is the positivism paradigm. This paradigm allows for measurements, objectivity and the design of universal laws (Oates, 2006:283-285). The positivism paradigm will be used as it supports the different research methods that are needed to achieve all the objectives in this study.

To achieve objectives one and two (determining the effect of using and playing location-based technologies, services and game on security awareness) a survey will be carried out. The next four objectives (developing a framework to determine the suitability of SDMs to aid in location-based games development) will incorporate a survey, as well as design science as research methods. The last three objectives (developing and testing an SDM for location-based game development) will incorporate design science as a research method. In summary, the research methods for this study include surveys, as well as design science, which are all supported by the positivism paradigm.

1.4.2. Research Method

The different research methods to be used in this study are as follows:

1. The gathering of information by using a survey. There will be two surveys carried out in this study. The first will be to determine whether or not there is a difference between users and non-users of location-based technology, services and games regarding security awareness. The second survey will be employed to rank the importance of each of the identified aspects that need to be addressed during the development of a location-based game. This survey will also identify aspects that have been neglected in order to include them in this study.
2. Design science will be used to develop the artefacts in this study. The first artefact of this study is a framework that can be used to analyse the suitability of SDMs to aid in the development of location-based games. This artefact will also be tested by allowing independent developers to use the framework. The second artefact is an SDM that is better suited for the development of location-based games, namely the Developmental Methodology for Location-Based Games (DMLBG). As part of the evaluation step in the design science research method this artefact will be tested by using four different case studies. Each case study will consist of indie developers who will be asked to develop a location-based game while using the DMLBG. After the successful development of the location-based games, the indie developers and project managers will be asked to

critically evaluate the DMLBG. This evaluation will then be applied to enhance the DMLBG.

An in-depth discussion of the research paradigm, research methods and the application of these is given in Chapter 2.

1.4.3. Research roadmap

Figure 1-1 shows the research roadmap. This figure also shows the different phases that will be used to achieve the sub-objectives of this study, as well as the dependencies of the different phases.

In the first phase, security awareness and the use of location-based services, technologies and games, it will be shown that computer science students are not as security aware as they should be. This information will be used in the following phases to ensure that the purposed methodology incorporates and implements security as one of the development aspects.

In the second phase the development of a framework to determine the suitability of SDMs for location-based game development will be carried out. In this phase different SDMs will be analysed to determine their suitability for developing location-based games.

In the third phase the development of the Developmental Methodology for Location-Based Games (DMLBG) will focus on developing the methodology itself. The results of the suitability framework should produce a list of steps and techniques that will be used to develop the DMLBG. Furthermore, the security concerns raised in the first phase will also be addressed in the development of the DMLBG.

In the fourth phase the DMLBG will be tested by independent (indie) games developers. The indie games developers will give feedback, which will then be used to refine and improve the DMLBG.

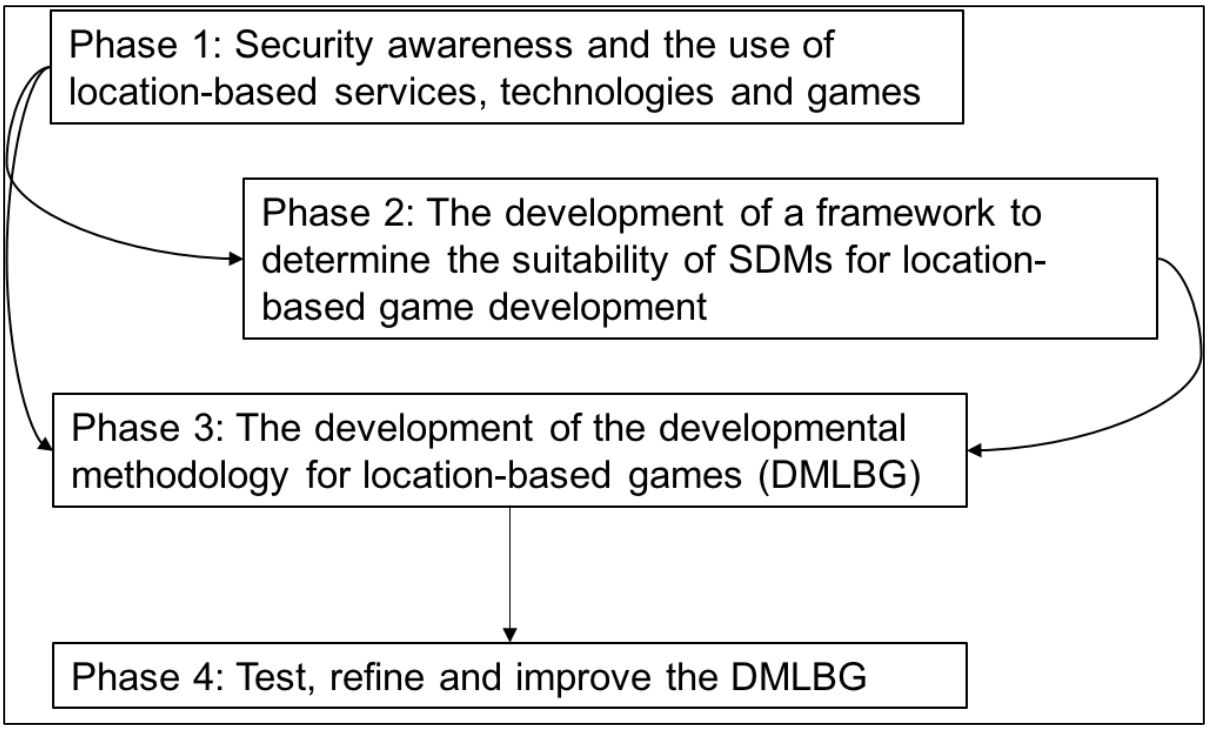


Figure 1-1: Research Roadmap

1.4. Chapter outline

In this thesis the process of developing an SDM that is more suitable for the development of location-based games is discussed. As this thesis describes the process of developing an SDM, the structure may vary from other traditional theses. This thesis resembles a thesis that consists of journal papers (the process of developing the SDM is based on three different papers that are currently under review). This process will consist of four different phases that will be followed. Chapter 3 through to Chapter 6 each describes one of these phases. Each of these chapters contains, where applicable, the following: introduction, literature review or theoretical background, an application of the research methods used in the phase, results, discussion or interpretation of results and a summary. Each of these phases or chapters can be regarded as a complete smaller or sub-study that contributes to the development of the SDM. Included in this thesis is a variety of appendixes. The reason for the appendixes is that the quantity of the information contained in each of them is too large to include as part of the text in each of the phases. The information in the appendixes contains the questionnaires used in this study, as well as all the results obtained from a specific phase. A brief description of each of the chapters follows.

In Chapter 2 the research paradigm and methods used to conduct this study are explained in greater detail. There is also an indication of the research methods used in the four phases.

In Chapter 3 the first phase of this process is presented. In this phase an on-line survey was used to gather information from computer science students to determine if there is a difference between users and non-users of location-based services, technologies and games regarding their security awareness (**Appendix 1**). The survey consists of three sections, each focusing on a specific topic. In the first section demographic information is collected. In the second section information regarding the participants' use and playing habits of mobile location-based technologies and games will be collected. In the third section questions regarding the awareness of the security risks in location-based services, technologies and games, as well as the implications should location-based data be compromised will be posed. Different statistical methods will be used to analyse the information gathered from the participants.

Descriptive statistics were used to report on the participants' habits in using location-based technologies, services and games. Factor analysis was used to group security awareness questions together in relevant security awareness variables. Independent t-tests were used to determine if there is a difference between users and non-users of location-based technologies, services and games regarding security awareness (**Appendix 2**). In this phase it was found that there is a marginal difference between the security awareness of users and non-users. The most important result of this phase was that although the participants think that they are taking preventative measures to secure their location data, the reality is that they were not.

In Chapter 4 the second phase used to develop the SDM for this study is reported on. In this phase a framework was developed to measure the suitability of SDMs in aiding the development of location-based games. The phase identified the features that can be included in location-based games. These features were gathered from current and relevant literature. These features are included as an extended definition of a location-based game. A list of aspects commonly associated with the development of mobile games, mobile applications and traditional games was also compiled from current and relevant literature. An on-line survey to rank the importance of each aspect was created (**Appendix 3**). The survey also included a section that allowed the participants to add aspects if any were overlooked. The survey was distributed to games developers in the industry to rank and add aspects. The ranking of aspects, as well as each aspect were used to develop the framework.

Eight SDMs were chosen that are mostly associated with game, mobile and mobile game development. The framework was used by three developers, as well as the researcher to determine the suitability of each SDM in aiding in the development of location-based games

(**Appendix 4**). According to the framework, none of the chosen SDMs was perfectly suited for the development of location-based games.

The third phase of developing the SDM for this study is discussed in Chapter 5. In this phase a new SDM, that is more suitable for the development of location-based games, was developed. In this phase the framework that was developed for measuring the suitability of SDMs to aid in the development of location-based games was used. Furthermore, in this phase eight SDMs that are mostly associated with game, mobile and mobile game development were analysed. The results of the framework identified the strengths and weaknesses of each SDM in respect of addressing the aspects needed for location-based game development. As mentioned, the results of the framework indicated that none of the SDMs was perfectly suited for the development of location-based games. This was then used to develop the DMLBG that would address all the aspects and needs for developing a location-based game (**Appendix 5**). Furthermore, the DMLBG would also be more suitable to aid in the development of location-based games.

In Chapter 6 the fourth phase of this study is discussed. In this phase the DMLBG was used in four case studies. Four teams were asked to develop a location-based game using the DMLBG. The teams were to document their experience of each step, as well as critically criticise the process (**Appendix 6**). The feedback from the team members was used to refine the DMLBG.

Chapter 7 of this study is the conclusion.

Table 1-1 shows the sub-objectives listed in Section 1.2, as well as the phases in which they were addressed. The last chapter, Chapter 7, discusses the results, limitations, future work and contributions of this study.

Table 1-1: Phases addressing sub-objectives

Sub-objectives	Phases addressing the sub-objectives
1 and 2	Chapter 3 (Phase 1: Security awareness and the use of location-based services, technologies and games)
3, 4, 5 and 6	Chapter 4 (Phase 2: The development of a framework to determine the suitability of systems development methodologies for location-based game development)
7	Chapter 5 (Phase 3: The development of DMLBG a systems develop methodology for location-based games)
8 and 9	Chapter 6 (Phase 4: Test and refine the DMLBG)

1.5. Expected Contributions

Each of the phases of this study had a significant contribution. Without divulging the result, the main expected contributions of this study are:

1. Determining if security measures are taken when location-based technologies, services and games are used. This is an important expected contribution as it poses a very high security threat for the computer science students that make use of these location-based technologies, services and games. This can also be incorporated in the development process of location-based games to ensure secure development of location-based games. The results of this study can also be used to indicate whether or not development companies need to increase their secure development process, as well as to indicate whether or not computer science students' security awareness in this regard needs to be increased.

2. The development of a framework that is capable of analysing SDMs to determine their suitability to aid in the development process of location-based games will be attempted. This could potentially be an important contribution as at the time of this study there was no tool that was capable of doing this. Furthermore, this could be used to develop a more suitable SDM for aiding in the development of location-based games.
3. The development of an SDM that is more suitable for location-based games. The developed SDM will be tested and refined by developing location-based games while following the developed SDM. This could potentially be an important contribution as at the time of this study there was no SDM specifically developed for location-based games.

1.6. Summary

The main focus of this study is to develop an SDM that can aid in the development of location-based games. As far as the researcher is aware, there is no specific SDM that can aid in the development of location-based games. Therefore, there is a need to investigate and if possible to contribute an SDM for location-based game development.

To be able to achieve the development of an SDM, nine sub-objectives were set. The development of the SDM will be carried out in four phases. Each of the phases will address a subset of the sub-objectives that needs to be achieved for the successful development of the SDM. Each of the phases is presented in its own chapter spanning from Chapter 3 through to Chapter 6. The outcomes of all the objectives will be presented in Chapter 7, the conclusion of this study.

The research design of this study will subsequently be described in greater detail in the next chapter.

Chapter 2 Research Design

The main objective of this study is to develop an SDM that is better suited to aid in the development of location-based games. To achieve the main objective, nine sub-objectives were set. In achieving these nine sub-objectives, three major contributions will be obtained, namely determining the security awareness of location-based technologies, services and games of computer science students, a framework that can evaluate SDMs' suitability to aid in the development of location-based games and the DMLBG that is an SDM that can be an aid in the development of location-based game development.

To be able to achieve all the sub-objectives, this study was divided into four phases. Each of the phases addressed a selected portion of the sub-objectives. The participants in this study included computer science students and indie games developers.

In this chapter the research paradigm, as well as research methods for this study will be discussed in greater detail. This study used the positivism paradigm as it supports all the research methods that are needed to achieve the sub-objectives. The research methods used in this study include surveys and the design science research method. In this chapter there will also be an indication of which research method was used to achieve which of the objectives.

2.1. Research process

This study focuses on developing an SDM that is better suited to aid in the development of location-based games. A literature study was carried out to determine whether or not there is an SDM for location-based games. It was found that there is no specialised SDM for the development of location-based games. Included in the literature study are different SDMs that could potentially be used for the development of location-based games and which were incorporated in the development of the DMLBG. In Figure 2-1 a summary of the research process for this study is presented.

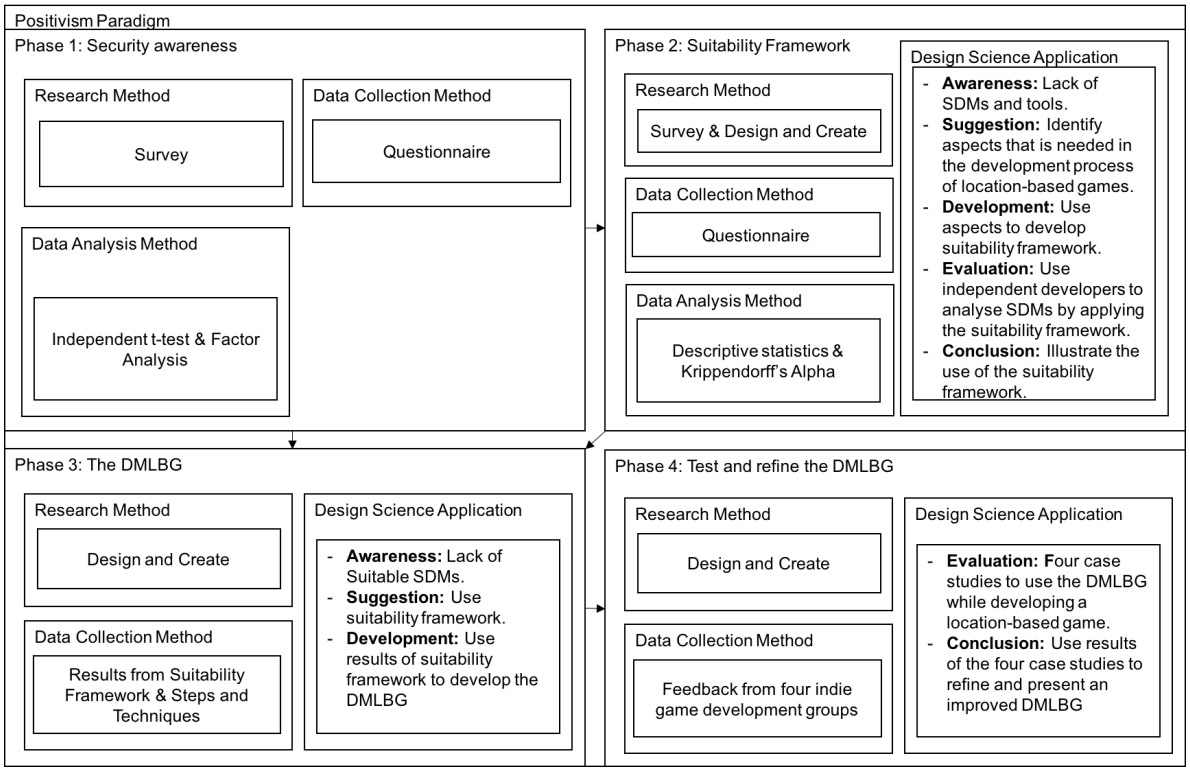


Figure 2-1: Summary of research process

The development of the new SDM was a process in which different phases were followed. Each of the phases in this development process needed to use a different set of research methods. The research paradigm that was followed throughout the development of the DMLBG was the positivism paradigm as it allows for the use of all the research methods needed to conduct this study.

In the first phase of this study the security awareness of computer science students was determined. The literature showed that in general there is a big security concern regarding the use of location-based services, technologies and games. This was incorporated in the SDM to ensure more secure location-based game development. The research method used in this phase was a survey. The data collection method used for the survey in this phase was an on-line questionnaire. The results of the on-line questionnaire were analysed by using descriptive statistics and independent t-tests.

In the second phase of the study a framework that could be used to analyse the suitability of SDMs with regard to location-based game development was developed. To achieve this, a list of aspects required in the development process of location-based games was identified by using relevant literature. This list was then given to games developers to rank the importance of each of these aspects, as well as to determine if any aspects were missed. After this process 15 aspects that are needed for the successful development of location-

based games were identified. The 15 aspects with their ranking were then used to form the suitability framework. The research methods for this phase included a survey (for the ranking of the 15 aspects) and the design science research method (for the development of the suitability framework). The data collection method used for the survey in this phase consisted of an on-line questionnaire. The questionnaire was analysed by using the following statistical methods: average, median, minimum, maximum, standard deviation and frequency analysis. The results were used in developing the suitability framework. The suitability framework was then tested by allowing independent developers to use the suitability framework to assess the suitability of eight SDMs to aid in location-based game development. The results of each independent developer were combined to determine the overall suitability of each of the SDMs. Krippendorff's alpha was used to determine inter-coder reliability.

In the third phase in the development of the DMLBG the results of the suitability framework analysis in the previous phase were used to develop the DMLBG. In this phase of the study the design science research method was used to develop the DMLBG.

In the fourth phase in the development of the DMLBG the SDM was tested. Four indie game development groups were tasked to follow the DMLBG rigorously, to document each step and to give critical feedback while developing a location-based game. The feedback from the teams, as well as the documentation and how each of the steps was executed were analysed. This was used to refine the DMLBG. The research method for testing the DMLBG comprised the evaluation step of the design science research method that was used to develop the DMLBG.

2.2. Philosophical paradigm

A research paradigm can be regarded as shared assumptions or having similar ways of thinking that can focus research (Oates, 2006:282). Furthermore, a research paradigm allows the researcher to communicate different shared visions and opinions, to shape the individual worldview and to benefit research and creative knowledge contribution (Oates, 2006:282). There are different research paradigms that can be chosen for different research purposes. Each of the research paradigms has its own worldview and shared thinking along with its own research methods (Oates, 2006:282). Some of the different paradigms include interpretivism, critical research and positivism.

A study that follows the interpretivism paradigm aims to understand the social context in information systems, as well as the relationship the social context has with the surrounding

world (Orlikowski & Baroudi, 1991; Oates, 2006:292). A study that follows an interpretivism paradigm does not seek to prove a hypothesis or predict and understand the occurrence of a phenomena (Orlikowski & Baroudi, 1991; Oates, 2006:292). Interpretivism seeks to identify, explore and explain people and their perspective on the world around them (Oates, 2006:292-294). Interpretivism also uses the researcher as an instrument for observation, selection and interpretation (Lee, 1999).

The critical research paradigm focuses on identifying the power relationship, conflicts and contradictions occurring in the computer and information systems domain (Oates, 2006:296). In other words, the main objective of the critical research paradigm is to empower individuals to eliminate the identified area of concern (Oates, 2006:296). Typical research associated with the critical research paradigm focuses on power within an organisation and the ways in which economy, race, social class, gender, ideologies, education, religion and culture form a social system (Kincheloe & McLaren, 2002).

To be able to conduct this study, the positivism paradigm was chosen and the detailed discussion of the paradigm will follow. It was decided to choose the positivism paradigm as it is the most suitable for the type of research in this study. The reason for this was based on the different research methods associated with the positivism paradigm that include surveys and the design science research method, all of which are used in this study. The interpretivism and critical research paradigms focus more on social research, which was found not to be relevant for this study (Kincheloe & McLaren, 2002; Phoenix *et al.*, 2013).

2.2.1. Positivism paradigm

Research has a certain underlying philosophy or is conducted in a specific methodical research paradigm. A research paradigm can be described as a shared belief system that guides the knowledge that the researcher seeks to obtain and the way in which the researcher interprets the evidence (Johnson & Onwuegbuzie, 2004; Morgan, 2007). In this study the positivism paradigm underlying the scientific method was used.

The positivism paradigm, which underlies the scientific method of research emphasises research in the natural sciences (Oates, 2006:282-285; Phoenix *et al.*, 2013). This paradigm has two basic assumptions: the first is that the world is ordered and regular and not random and the second is that the world can be investigated objectively (Orlikowski & Baroudi, 1991; Phoenix *et al.*, 2013). Furthermore, the positivism paradigm describes nature, meaning that the research conducted in this paradigm is grounded and objective, and represents a factual account of the evidence that supports the research project (Orlikowski & Baroudi, 1991; Phoenix *et al.*, 2013). Computer scientists who conduct research in the positivism paradigm

see the world as uniform in relation to their current research project (Oates, 2006:282-285). This paradigm is also favoured by computer scientists and information system researchers as the nature of the research field of computer science and information systems does not always allow for conventional research methods and data collection methods (Oates, 2006:286). Some of the characteristics associated with the positivism paradigm are (Lee & Baskerville, 2003; Oates, 2006:286):

- The world exits independently of humans: Aspects of the physical and social world can be captured, measured and studied. These can be done independently from each other.
- Measurements and modelling: Models of the working world can be produced by the researcher using observing and measuring of the real world.
- Objectivity: The researcher is neutral and is free to discover facts about the real world without bias of his/her own values.
- Hypothesis testing: The refuting or confirmation of theories and hypotheses by using empirical testing.
- Quantitative data analysis: Can be viewed as the building of mathematical models and proofs, and statistical analysis, which is a logical and objective means of analysing observations.
- Universal law: Researchers strive to look for generalisation. The universal laws, patterns or irrefutable facts can be represented to be the truth regardless of the conditions in which the research was conducted.

The positivism paradigm was chosen because the survey and the design science research method used in this study are supported by it. Furthermore, this study also used most of the characteristics mentioned associated with the positivism paradigm as follows:

- The **measurements and modelling** characteristic is used in the design science method to develop a framework and an SDM.
- The **objectivity characteristic** was utilised as follows: statistical methods were used to analyse the surveys, the framework was used by independent developers, and the SDM was tested in four case studies, which produced documentation that was analysed. All this was done without the researcher influencing the participants.
- **Quantitative data analysis** was used when analysing the surveys.

The characteristics of the positivism paradigm that are not applicable to this study are:

- **The world exits independently of humans**: this study did not try to capture aspects of the physical world.
- **Hypothesis testing**: There were no hypotheses made or tested in this study.
- **Universal law**: In this study, to construct a new universal law was not one of the objectives.

It is clear from the above-mentioned that the positivism paradigm was chosen as it supports surveys and the design science research method used for the successful completion of this study.

2.3. Research Methods

Research methods are usually the approach a researcher will use to answer the research question (Mouton, 2011:55). Furthermore, the research methods employed by the researcher allow for the collation of empirical data or evidence to support the research, as well as to aid in drawing conclusions (Mouton, 2011:55). The research methods that were used to conduct this study are surveys, which were used to gather data from the computer science students and games developers, as well as the design science research method that was used to develop the artefacts (the suitability framework and the DMLBG) in this study. A discussion of each of the research methods, as well as how each of the research methods was used will follow.

2.3.1. Survey

A survey is used to gather data from a large population of people to determine the common denominator and to standardise the results (Pinsonneault & Kraemer, 1993). After the data has been standardised and generalised the researcher can search for patterns in the data (Kruger *et al.*, 2005). Surveys can incorporate various data collection techniques, such as questionnaires, observations and documentation. The reason that a survey was used in this study was that surveys allow for quantitative data collection, such as questionnaires (Fouché & De Vos, 2005). This study used questionnaires in two of the phases. The first was to determine the awareness of computer science students with regard to location-based games, services and technologies. The second was to validate the aspects needed in the development process of location-based game development. The reasons why questionnaires were chosen in this study are (Oates, 2006:220):

- The study needed to obtain data from a large number of respondents.
- Relatively brief and uncontroversial information needed to be obtained.
- Standardised data needed to be obtained.

- The questionnaire had to be distributed online.

The description of how each of these surveys were executed will follow.

2.3.1.1. Survey to determine the security awareness of computer science students

This survey was a convenience sample that consisted of participating students from a university in South Africa. The participants are all computer science students. The assumption was made that computer science students are more likely to be tech-savvy and it is believed that they represent early adopters of technology, which is likely to include location-based technologies, services and games. An on-line questionnaire was used to acquire the data. The full questionnaire can be seen in **Appendix 1**.

Participants in one computer science or information system module of each study year were asked to complete the questionnaire in the computer laboratories in the last quarter of 2013. The participants ranged from first-year to honours (fourth-year) computer science students. The on-line questionnaire used the student's identification number (ID) to allow access to the online questionnaire to avoid one student submitting multiple questionnaires. The login was not matched to the completed questionnaire of the student in order to keep the students' answers anonymous. By keeping the logon detail in a separate database with no link to the database that contained the actual answers of the completed questionnaires, anonymity was enforced. The computer science students were also asked to complete the questionnaire on a voluntary basis. The first page of the questionnaire informed the participants about the purpose of and goals to be achieved with the questionnaire.

Independent t-tests were used as an analysis method to determine if there was a difference in the security awareness between the participants that use and participants that do not use location-based technologies, services and games. The statistical analysis was done in SPSS. The independent t-test was chosen as it allows the comparison of two means from different group entities to be able to determine if there is a difference between the two groups. The complete set of independent t-test results can be seen in **Appendix 2**.

In **Chapter 3**, in the section: **The application of the research method**, a full discussion of the questionnaire is provided. Furthermore, in **Chapter 3** in the section: **Results of analysing the security awareness survey**, a full discussion of the descriptive statistics, the data analysis method (independent t-test) and how to interpret the results of the questionnaire are presented.

Data validity

A pilot study was conducted to test the questionnaire. The objective of the pilot study was to evaluate the validity and simplicity of the questionnaire. Two participants from each of the year groups were selected to participate in the pilot study. The participants completed the questionnaire in an interview environment in the presence of the researcher. As the participants completed the questionnaire, the researcher captured the feedback from and the ideas and uncertainties of the participants. The researcher used this information to improve the quality of the questionnaire by doing the following:

- Adding additional questions to the questionnaire if certain location-based technologies, services and games were missing.
- Changing the format, wording or options for a question to be more understandable for the participants of the pilot study.
- Participants in the pilot study would also indicate where the on-line questionnaire did not lead them or where the flow of the questionnaire was confusing.

The questionnaires completed by the participants that took part in the pilot study were discarded in order not to be included in the results.

Factor analysis was used to group relevant research variables together. This process yielded two factors. The validity and integrity of each of the factors were tested by using Cronbach's alpha. The Cronbach's alpha for each factor was 0.86 and 0.21 respectively. The factor that yielded a Cronbach's alpha of 0.21 was discarded as the test did not have a value greater than 0.7 and the individual research variables were used. For a more detailed description of the factor analysis used for this portion of the study, the reader is referred to **Chapter 3** in the section: **Factor analysis**.

For a research item to be included in the independent t-test, either one of the two groups (Non-User, User) must have had a minimum of twenty participants in the group. As the total participants in the group are 243, twenty was the minimum representation to represent a group. For a more detailed description of the independent t-tests used in this portion of the study please refer to **Chapter 3** in the section: **Independent t-test**.

2.3.1.2. Survey to validate the aspects needed in the development process of location-based game development

The survey that was used to determine the validity of the aspects that are needed in the development process of location-based games presented some challenges with regard to

getting feedback from the gaming companies. The data-gathering method used for this survey was a questionnaire. It could be speculated that most of the gaming companies would not like to share their success in this very competitive market. After targeting gaming companies, indie gamers were targeted. It was also problematic to get feedback from them. Lastly, game development research labs and researchers were targeted. This group was a little more open than the other two groups, although there are not many gaming labs or researchers that specialise in the development of location-based games. The response rate of the survey cannot be calculated accurately, as different forms of media were used to reach the respondents.

The different types of media that were used to gather information via the survey were: email, an on-line survey, email groups and social media. The first attempt at gathering information was done by attaching the questionnaire to an email and mailing the email to gaming companies and research labs. Only 15 completed questionnaires were gathered in this attempt. However, the respondents indicated that it would be better to develop an on-line survey. This was done in Google Docs (https://docs.google.com/forms/d/1S-0XcYJqJbUwgsdR-5fcEpQZrzFzQqDey3H-uaeRMl0/viewform) and the email was once again sent with the link to the questionnaire attached. An example of the questionnaire can be seen in **Appendix 3**. The email was sent to the same group of developers that did not answer in the previous round. The response rate was still not good with only 19 completed questionnaires gathered. However, one of the respondents suggested asking for help from a game research group. The name of the group is gamesnetwork@listserv.uta.fi. Once again only 17 completed questionnaires were gathered. After this the questionnaire was posted on a few gaming community groups on LinkedIn. These groups specifically cater for games developers and include: Android Game Development, design3, Games Developers, Games Developers Group, Game Development & Design, Game Development Business, Gaming Passion and Profession, Mobile Game Development, The Online Game Group, Video Game Professionals and iPhone Android Mobile App Design, Development & Promotion. The rest of the questionnaires, that is 27, were gathered through this attempt. By this process, 78 completed questionnaires were collected during the survey.

Due to the lack of willing respondents, the survey made use of convenience sampling and consisted of a questionnaire that contained 15 questions, each representing one of the aspects that will be described and analysed in **Chapter 4** in the sections**: Aspects needed to be addressed in the development process of location-based game development** and **Evaluation and verification of the aspects** respectively. Each of the questions asked the participant to rank the importance of an aspect in relation to the development process for

location-based games on a scale of one to ten where one was the least important and ten was most important.

The results of the survey will be used to determine the importance of an aspect for developing location-based games. In addition, the survey also had open-ended questions that allowed the respondents to add additional aspects if any were overlooked. Descriptive statistics were performed on the data. The average score for each aspect will be used as a weight to help score each SDM's suitability with regard to location-based development. Furthermore, frequency analysis was done on the data to show the frequency distribution of each question and the number of times each ranking occurs. For a more detailed discussion on the results of the survey, analysis methods used, and open-ended questions for this survey please refer to **Chapter 4** in the section: **Evaluation and verification of the aspects**.

Data validity

In addition to the average, the median, minimum, maximum and standard deviation were calculated to demonstrate the grouping of the data. Each aspect received a value between one and ten based on the importance indicated by the participants. Most of the aspects' standard deviations indicate a score between 1.77 and 2.73 with a total standard deviation for the entire dataset of 2.44. This indicates that most of the games developers ranked the aspect the same with an average deviation of 2.44 signifying that the games developers do agree on the rank of each aspect. The average for the entire dataset is 7.33. This indicates that the developers mostly ranked the aspects around 7.33. Combining the total average with the total standard deviation of 2.44 it can be seen that most of the data were spread through 7.33 +/-2.44. The rankings of the aspects seem to indicate that the games developers agree with the identified aspects. Although the games developers agree with the identified aspects, it is important to analyse the open-ended questions in order to add overlooked aspects that the games developers identified. For a more comprehensive discussion of these results for this survey, the reader is referred to **Chapter 4** in the section: **Evaluation and verification of the aspects**.

The aspects that were identified were matched to the answers of the open-ended questions and added to the additional aspects if there were any. The open-ended questions that did not have a match were evaluated to determine whether or not it was a new aspect that was not included in the original list. If the response to the open-ended question did not have a match or there was no valid reason to reject it as an aspect, it was added to the list of aspects.

2.3.2. Design science

Design science is a problem-solving approach that allows the researcher to develop an artefact as part of the research process (Vaishnavi & Kuechler, 2004; Iivari, 2007). The researcher can use the artefact to explore and exhibit the potential outcome of the research study for the technological world (Hevener *et al.*, 2004; Iivari, 2007). If a researcher decides to develop an artefact as a research project, it should not only demonstrate technical ability, but also have academic merits, such as analysis, explanation, arguments, justification and critical evaluation (Oates, 2006:108-110). The design science method aids the researcher to develop an artefact as a research project by including the five steps associated with design science, namely awareness, suggestion, development, evaluation and conclusion (Vaishnavi & Kuechler, 2004). There are different types of artefacts that a researcher can develop, namely constructs, models, methods and instantiations (Hevener *et al.*, 2004). The reason for choosing the design science method is that in this study two different artefacts are developed. The first is the framework to evaluate the suitability of SDMs to aid in the development of location-based games. This artefact is a model. The second artefact developed is the SDM called the DMLBG. This artefact can be regarded as a method. A description of each of the artefacts developed follows.

2.3.2.1. Framework to evaluate the suitability of SDMs

The aspects that needs to be addressed during the development of location-based games were identified and validated by the gaming community and were used to develop the framework. Each of the aspects was given a weight (w) based on the ranking that the gaming community gave the specific aspect. This was calculated as the average of all the participants' responses for the aspect. The framework allows for multiple SDMs to be evaluated simultaneously. Furthermore, the framework can also calculate the suitability of an SDM for a specific aspect or the suitability of the SDM for all the aspects.

For the development of the evaluation framework of SDMs, different steps need to be followed. These steps are: awareness, suggestion, development, evaluation and conclusion. Each of these steps will be addressed in the development of the framework for this study. These steps are addressed as follows (Vaishnavi & Kuechler, 2004; Oates, 2006:111-112):

- Awareness: Becoming aware of the lack of SDMs and research of SDMs for location-based games and the subsequent lack of aspects that are needed in the development process of location-based games.
- Suggestion: Identifying the aspects that are needed to be addressed by SDMs in the development process of location-based game development.

- Development: Verify these aspects by using a survey. Based on the results of the survey, the framework will be developed.
- Evaluation: Use the framework that has been developed to analyse identified SDMs to determine their suitability to aid in the development of location-based games. The data in the examples of the framework were gathered by asking three different independent developers to use the framework to evaluate the list of SDMs along with the researcher's evaluation. The results of using the suitability framework can be seen in **Appendix 4**. For a more comprehensive discussion on this please refer to **Chapter 4** in the section: **Evaluation of SDMs**. To determine to what extent all the developers and researcher scored the aspects for each SDM the same, Krippendorff's alpha was used. An α value larger than 0.8 is the norm for a very good reliability, followed by an α smaller than 0.8 and larger than 0.67 as a good reliability and α-values smaller than 0.67 being rejected. These results proved good inter-coder reliability for scoring the aspects and SDMs and that none of the scores needed to be excluded. The full description and results for this can be seen in **Chapter 4** in the section: **Inter-Coder Reliability**.
- Conclusion: Illustrate the use of the framework and how it can benefit games developers in choosing SDMs or developing an SDM that better suits their needs. The framework will be used to evaluate different SDMs simultaneously to determine to what degree each SDM addresses a specific aspect needed in the development process of location-based game development. The developers can use this information to either choose the SDM that suits their needs better, only choose portions from different SDMs and combine them into one development process or develop a new SDM to suit their needs. The comprehensive discussion of these results is presented in **Chapter 4** in the section: **Evaluation of SDMs**.

2.3.2.2. The development of the DMLBG

The framework to determine the suitability of SDMs to aid in the development of location-based games was used to develop the DMLBG. This SDM will be developed to specifically aid in the development of location-based games. The suitability analysis obtained from applying the suitability framework to the identified SDMs and aspects will indicate the shortcomings and strengths that each SDM aspect pair has. This can then be used to combine the best techniques and steps of each SDM aspect pair, as well as compensate for the shortcomings. This will be the basis on which the SDM will be developed. Different steps are associated when using the design science research method. These steps are awareness, suggestion, development, evaluation and conclusion. These steps were executed as follows (Vaishnavi & Kuechler, 2004; Oates, 2006:111-112):

- Awareness: Becoming aware of the lack of SDMs that are suitable for the development of location-based games and the lack of research of SDMs for location-based games.
- Suggestion: Use the results obtained by using the suitability framework. Use these results to identify all the strengths that each SDM has in aiding in the development of location-based games. This identified list of steps and techniques can be used to develop a new SDM. The discussion on the list of steps and techniques can be seen in **Chapter 5** in the section: **Steps and techniques identified by using the Suitability framework**.
- Development: Use the list of identified strengths as mentioned above and construct a new SDM. The strengths can be regarded as a list of steps and techniques in **Chapter 5** in the section: **Steps and techniques identified by using the Suitability framework**. The complete set of mappings on how the DMLBG was developed from these steps and techniques can be seen in **Appendix 6**. The full description of the development of the DMLBG is given in **Chapter 5** in the section: **The development of the DMLBG**.
- Evaluation: Allow the DMLBG to be used by indie games developers as four different case studies. A case study can be used to focus on one instance of the "thing" that is under investigation (Oates, 2006:141-142). In the case of this study, the "thing" on which the case study is going to focus is the DMLBG that the indie games developers followed. There are three different types of case study, namely (Yin, 2013:14-23):
  - Exploratory: This case study is used to define the question or hypothesis to be used in the study. This can help the researcher to understand the research question, specifically when there is little literature about the subject.
  - Descriptive: This case study leads the researcher to rich and detailed analysis of a specific phenomenon and how different people experience it.
  - Explanatory: This case study tries to explain a phenomenon that happened or why the outcome of the phenomenon was obtained.

  This study used four different descriptive case studies, meaning that these case studies were used to lead the research to a rich and detailed analysis of the use of the developed SDM, how different teams experienced the use of the developed SDM and compare the results between the case studies (Yin, 2013:7-9, 21-23). This is another reason why the case study was chosen as a research method. Various data collection methods can be used to conduct a case study, such as interviews, observation, document analysis, and detailed insight into the life of the case study

(Oates, 2006:148). As this study's underlying paradigm is the positivism paradigm, the analysis of documentations is used to gather data (Oates, 2006:148).

The four case studies for this study will consist of indie games developers with a project manager. A more comprehensive discussion of each case study is given in **Chapter 6** in the section: **Case Studies**. Each of the developers will have a specific task and each team will have a project manager. Each team will develop a location-based game by strictly following the DMLBG. Each week each team will gather and raise issues and make comments about the SDM. This will be documented and be used to adjust and refine the SDM to reflect a more realistic take by a development team. The analysis for each of the case studies can be seen in **Appendix 6**. The refined version of the DMLBG is presented in **Chapter 6** in the section: **Refine and improve the DMLBG**.

The inclusion criteria for the developers who participated in the case studies were firstly, they needed to have at least completed some course work in software engineering or similar course that allowed them to analyse SDMs, and secondly, the developers should also be enthusiastic games developers with some experience in games development (even if it was only done as a hobby). The inclusion criteria for the project managers were the same as for the developers, with the difference that they needed to have a higher level of course work in project management completed, as well as having some practical experience in following/managing an SDM. The age of the participants was between twenty-two and thirty years. Most of the developers who participated had at least a BSc or BSc (Hons) degree in Information Technology or Computer Science. Participants of the study were approached through post-graduate project management classes presented at the university. The participants were post-graduate students that had to have completed courses that included games development, as well as information engineering courses that allowed them to analyse, use and understand SDMs.

- Conclusion: Use the results from the four case studies to refine and improve the DMLBG. The refined version of the DMLBG is given in **Chapter 6** in the section: **Refine and improve the DMLBG**.

Based on the suitability analysis, the suitability, as well as the strengths of each SDM in aiding the development of location-based games were identified. Based on this, the list of steps and techniques was constructed, which is presented in **Chapter 5** in the section: **Steps and techniques identified by using the Suitability framework**. This list acted as a

short list of steps and techniques that could be chosen from to be included in the DMLBG. The comprehensive set of mappings of these steps and techniques to the steps in the method of the DMLBG are given in **Appendix 5**.

2.4. Summary

This chapter described the research process followed in this study. To be able to achieve the main objective of this study, different sub-objectives were identified. The development of the SDM was done in phases where each phase had a set of the sub-objectives that the phase needed to address. The positivism paradigm was identified as the research paradigm in developing the DMLBG. The reason for this was that the positivism paradigm supports the research methods used in this study.

The research methods used in this study included surveys and design science. These research methods were chosen based on the sub-objective that needed to be addressed. There are two surveys in this study. The first survey was to gather data from computer science students in respect of their security awareness of location-based services, games and technologies and the second survey was to gather information from mobile games developers to rank the importance of the aspects needed in the development process for location-based game development. The design science research method will be used in two instances. The first to develop a framework to determine the suitability of SDMs in aiding in the development of location-based games and the second to develop the DMLBG.

The following chapters will describe the phases of development for the DMLBG. Each of the chapters will represent a phase of the development process used. Furthermore, each chapter will contain the supporting literature, sub-objectives and results obtained from the phase. The next chapter will elaborate on the first phase of the development process of the DMLBG. This phase focuses on the security awareness and the use of location-based services, technologies and games.

Chapter 3 Security awareness and the use of location-based services, technologies and games

This phase of the study is based on the research paper: **Security awareness and the use of location-based services, technologies and games**. The paper was submitted to the journal: **International Journal of Electronic Security and Digital Forensics**. Currently the status of the paper is: **Accepted**.

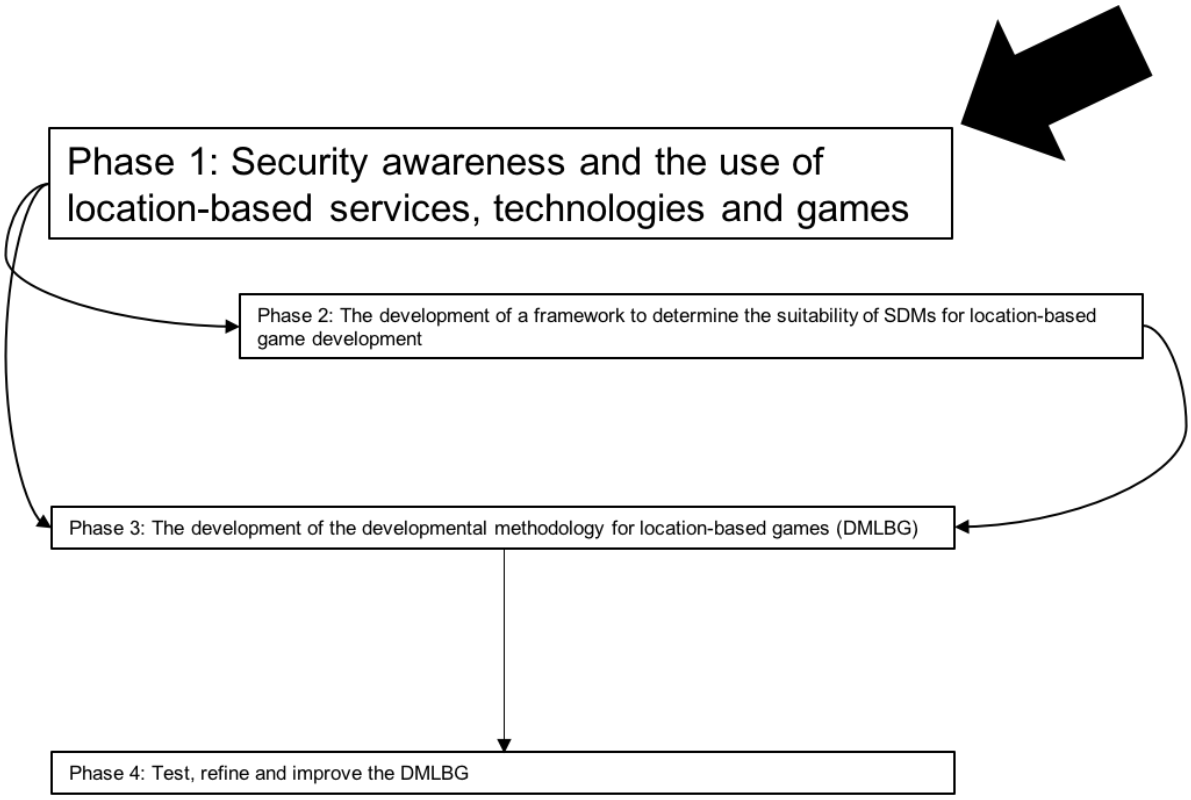


Figure 3-1: Research roadmap - phase 1

3.1. Introduction

Mobile devices have overtaken desktops and laptops in everyday use and have become important tools in day-to-day activities (Arunkumar *et al.*, 2015). Furthermore, mobile devices continuously connect to different services, such as Wi-Fi, cellular networks, the Internet and location-based services (Arunkumar *et al.*, 2015). The capability to connect to these different services can lead to security vulnerabilities (Arunkumar *et al.*, 2015). It is important for the users of these technologies to be aware of the security vulnerabilities that are associated with using these technologies.

Due to the rapid development of mobile technology, location-based services were made possible (Li *et al.*, 2014b). Mobile location-based services are services that take the

geographical location of the user into account (Junglas & Watson, 2008). This allows the user either to determine his/her location or to share his/her current location (Elkhodr *et al.*, 2012). According to a study by the research company, Juniper Research, in 2010, mobile location-based services would have accumulated more than $12.7 billion by the year 2014 (Juniper Research, 2010; Li *et al.*, 2014b). Due to this massive increase in the revenue of mobile location-based services, this phase (Figure 3-1) will focus on the security awareness of users of location-based services.

There are many different mobile applications that implement mobile location-based services. One of these types of application is location-based games. Location-based games are a type of ubigame, which forces the players of the game to use their location as input for the game (Buzeto *et al.*, 2014). This will convert the location data into game actions to immerse the player in the game world (Buzeto *et al.*, 2014). As mobile location-based games use mobile location-based services and technologies, the same security vulnerabilities are also associated with them. Therefore, this phase will determine whether the frequency of using mobile location-based services, technologies or playing mobile location-based games affects the awareness of computer science students with regard to security. Limited research on this has been done. This phase will endeavour to address this lack of research. The layout of the phase is as follows: in section 3.2 the sub-objectives addressed in this phase will be discussed in more detail followed by section 3.3 in which relevant theoretical background information will be presented. This is followed by section 3.4 where the results of the security awareness survey will be reported. In section 3.5 the results of the security awareness survey will be interpreted. Finally, the results for this phase will be summarised in section 3.6.

3.2. Sub-objectives

In this phase of the study an attempt will be made to determine the relationship between security awareness and the use of mobile location-based services, technologies and games. To achieve this the following sub-objectives have been identified:

1. Determine the effect of using mobile location-based technology and mobile location-based services on security awareness.
2. Determine the effect of playing location-based games on security awareness.

3.3. Theoretical background

3.3.1. Location-based technologies and services

Location-based technology is a group of technologies that has the ability to communicate physical location (Lemos, 2008). Mobile devices that are equipped with this improved location-based technology increased the use of location-based services (Patel & Palomar, 2014). This increased use, as well as the explosive growth of mobile devices that implement location-based technology, wireless communication and mobile databases has led to location-based applications (Mokbel, 2007). For the purpose of this phase, the focus will be on location-based technologies and software and hardware that are required to track physical location will be included.

In general, the hardware that are grouped together to achieve tracking of physical location are digital devices (smartphone and tablet), sensors and digital wireless networks (Global positioning system, Wi-Fi and Bluetooth) (Lemos, 2008). This group of hardware is also known as location-based technology. Location-based technology is usually integrated into mobile hand-held devices, such as smartphones (Kushwaha & Kushwaha, 2011).

Mobile location-based services use this mobile location-based technology to generate and exchange information about the location of the mobile device (Park *et al.*, 2005; Lemos, 2008; Kushwaha & Kushwaha, 2011). Moreover, a location-based service is an information service that is accessible to mobile devices and utilises the mobile network of the mobile device to determine the location of the mobile device (Kushwaha & Kushwaha, 2011). To simplify, location-based services have two major actions: one is to obtain the location of the user and the other is to use this information to provide a service to the user (Kushwaha & Kushwaha, 2011). There are many types of location-based service. A few examples are: location-tracking services (services relying on the tracking of the user by other parties, such as network providers or services that focus on particular coordinates (Barkhuus & Dey, 2003; Elkhodr *et al.*, 2012)), position-aware services (services that rely on the device's own knowledge of its position and using it and in addition supplying coordinates of surrounding context (Barkhuus & Dey, 2003; Elkhodr *et al.*, 2012)), trigger location-based services (the location of the user is retrieved by the server, also known as a push service (Kushwaha & Kushwaha, 2011)), and user-requested location-based services (the user decides when and where to retrieve location by activating location-based services on a device, also known as a pull service (Kushwaha & Kushwaha, 2011)). Location-based services rely heavily on network connectivity. The most popular network connectivity that location-based services

use to determine the location is GPS (global positioning system), Wi-Fi or cellular networks (Elkhodr *et al.*, 2012).

Location-based services have allowed the mobile users to download location-based applications from various mobile App stores (Niu *et al.*, 2015). There are different applications that are based on location-based services, for example point of interest applications (Wernke *et al.*, 2014; Song *et al.*, 2015), navigation (Wernke *et al.*, 2014; Song *et al.*, 2015), area-specific weather (Song *et al.*, 2015), map information (Song *et al.*, 2015), mobile marketing (Imran & Kavitha, 2014), public safety and emergency services (Doshi *et al.*, 2014), facility and friend finder (Doshi *et al.*, 2014), location-based social applications and services (Arunkumar *et al.*, 2015), mobile vendor (Song *et al.*, 2015), ubigames and location-based games (Buzeto *et al.*, 2014). These are just a few of the types of applications that use location-based services. Because of the high availability of mobile devices that use these location-based services and technology, it is important to determine the security awareness while using them. In this phase the focus will be on determining whether the use of these services and technology increases the security awareness or not.

3.3.2. Location-based games

Ubigames are games that span between the real world and the virtual world (Buzeto *et al.*, 2014). Location-based games is one of the genres developed from ubigames (Buzeto *et al.*, 2014). Location-based services led to the development of location-based games (Dubey & Singh, 2016), because location-based games use these services to determine the location of the player. Location-based games can be described as games that incorporate the player's location in the real world as a gaming mechanism (Venselaar, 2014). The player's position in the real world is interpreted as input that influences the progress of the gaming world (Venselaar, 2014).

Location-based services were a precursor for location-based games as mentioned. This led to location-based games being reliant on network connectivity to fully incorporate location-based services and thereby enabling the location-based game to determine the location of the player in the game. The same network configurations apply to location-based games as for location-based services. They are GPS, Wi-Fi and cellular networks. Most location-based games are developed for mobile devices, which incorporate location-based technology (Sintoris *et al.*, 2014).

In recent years a great number of location-based games have been developed (Avouris & Yiannoutsou, 2012). This is due to the widespread use of mobile devices that have the capability of determining the players' location (Ejsing-Duun, 2011; Venselaar, 2014). A few

examples of these games that are available on mobile phones are PacManhattan (New York University's Interactive Telecommunications graduate program), BotFighters (It's Alive Mobile Games AB), Geocaching (Groundspeak Inc.), CySMN (Mixed Reality lab, University of Nottingham), Tiny Tycoons (The Tap Lab, Inc.) and Feeding Yoshi (Glasgow University's Equator group in partnership with the University of Nottingham and the University of Lincoln) (Ejsing-Duun, 2011; Venselaar, 2014). The most successful and recently launched location-based game, Pokémon GO, also makes use of location-based services and technologies (Kostrzewski, 2016). Pokémon GO is so popular that within a week of its release the game had more users than Twitter and Tinder (Allan, 2016; Price, 2016). This game also contributed to a 25% increase in share value for Nintendo or around $9 billion in share price (Hussain, 2016; Makuch, 2016; Price, 2016). All these games make use of location-based services to determine the location of the players in the game. Some of the players might not even realise that they are using location-based services or be aware of the security risks involved in playing location-based games. Due to this fact, as well as the number of location-based games available, it is important for the player to know the risks involved in playing location-based games. Moreover, it is also important to determine whether playing location-based games increases the security awareness of location-based games or not. In this phase it will be determined whether the frequency of playing location-based games has an impact on the security awareness of the players or not.

3.3.3. Security awareness and related studies

One of the major problems with using location-based technology, location-based services and location-based games is the unauthorised disclosure of the user's location (Elkhodr *et al.*, 2012). Researchers, users, service providers and government organisations have been aware of this problem for a while (Avouris & Yiannoutsou, 2012).

For a hand-held device to determine the location, the hand-held device needs to be connected to a location-based service provider that can provide the hand-held device with the location data that is requested (Patel & Palomar, 2014). There are security threats associated with continuously querying the location-based service provider to determine the location of the hand-held device. These security threats are amongst others that the service provider can store the location data without the user's consent (Patel & Palomar, 2014). This can lead to the location data being shared with third parties (Patel & Palomar, 2014) or the location data can be stolen from service providers and leaked (Puttaswamy *et al.*, 2014; Wernke *et al.*, 2014).

Mobile vendors or proximity vendors who use location-based services to deliver services to customers can cause security threats to both the vendor and the customer (Yang *et al.*, 2012). Two different attacks are associated with this security threat (Yang *et al.*, 2012). The first is mobile-vendor attacks, where the vendor supplies false location information to the customer to obtain his/her business (Yang *et al.*, 2012). When the customer chooses the cheating vendor, he/she may have to wait longer for service than when choosing a vendor who was actually closer to his/her location (Yang *et al.*, 2012). The second is user attacks where the user submits a false request and denies applying for the specific service from the vendor or the user provides a false location claim where the user does not disclose his/her real location to the vendor (Yang *et al.*, 2012). These attacks can cause the vendor to lose other real business opportunities or to reduce other non-malicious customers from obtaining the vendor's services (Yang *et al.*, 2012).

Both of the above-mentioned security threats are examples of where a company (provider or vendor) or a customer could take advantage of the location-based data provided. The next security threat is attacks that are conducted by malicious parties, also known as attackers, who try to obtain a user's location data unlawfully to cause harm to that user. The examples that are going to follow are examples of security threats that specifically apply when obtaining location-based data. Besides the examples mentioned, there are more general security threats that can compromise the security of location-based data. These security threats are more general and applicable to any modern-day technology. In this phase the focus will only be on location-based security and on location-based security threats and not general threats.

The first of these attacks is known as the attacker knowledge (Wernke *et al.*, 2014). This is when the attacker has gained access to the user's temporal or contextual information (Krumm, 2009; Wernke *et al.*, 2014). A second attack is what is known as single-position attack (Bettini *et al.*, 2009; Wernke *et al.*, 2014). This attack is when an attacker analyses a single query of a user to try to infer the location of the user (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). The third kind of attack is known as context-linking attack (Wernke *et al.*, 2014). This attack is where the attacker exploits context information in addition to spatial information to determine the user's location (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). The fourth attack is called multiple-position attack and the general idea of this attack is to build a history of positions based on analysing multiple queries made by the user (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). The fifth attack is when an attacker combines more than one of these kinds of attack to gain access to the user's location data (Bettini *et al.*, 2009; Wernke *et al.*, 2014). The sixth attack is when

the attacker uses multiple users' information to determine the location of a group of users, and is also known as multiple-issuer attack (Bettini *et al.*, 2009). The last attack is when the attacker has knowledge about the defence mechanisms and exploits these mechanisms to gain access to the user's location data (Bettini *et al.*, 2009).

With all of the different kinds of attack that can compromise the security of location-based data, there are also different types of defence mechanisms that can be used to counter the security threats. Only security defence mechanisms that are used to protect location-based data will be discussed in this phase.

The first of the defence mechanisms is called position dummies and the goal is to secure the user's true position by sending multiple false positions to the location-based service provider together with the correct one (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). The second defence mechanism is called mix zones and secures the user's position by mixing the user's information with that of other users in these predefined zones to ensure that the attacker cannot track the user after entering and exiting one of these zones (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). A third defensive mechanism is called k-anonymity (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). This method is widely used to ensure the privacy in location-based data (Wernke *et al.*, 2014). K-anonymity provides the guarantee that in a set of k objects an object is indistinguishable from other objects and thereby ensuring the probability of identifying the specific user is 1/k (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). The fourth defence mechanism is called obfuscation and coordinates transformation. This defence mechanism deliberately tries to reduce the precision of position information that is sent to the location-based service provider (Bettini *et al.*, 2009; Krumm, 2009; Wernke *et al.*, 2014). A fifth defensive mechanism is to encrypt the location-based data to ensure that the attacker cannot interpret the information without decrypting it (Bettini *et al.*, 2009; Wernke *et al.*, 2014). The final defensive mechanism is called specialised queries and is intended to serve specific types of applications (Krumm, 2009). For this defensive mechanism the location-based data and queries would be predefined and the defensive mechanism would only need to take a pre-set of occurrences into account (Krumm, 2009).

All the above-mentioned attacks and defensive mechanisms try either to gain unlawful access or to defend against unlawful access to location-based data. The reason for this is that with this information, an attack can cause considerable harm to the user. Examples of the kind of harm that can befall the user if the location-based data is compromised will be provided next.

The first kind of harm an attacker can inflict is to physically harm the user whose location-based data is compromised (Bettini *et al.*, 2009; Krumm, 2009; Fusco *et al.*, 2010; Peddinti *et al.*, 2011; Cleveland, 2012). As the attacker has the location of the user the attacker can use this to find the user and to rob or kill the user. A second example is location-based data that is sold to third-party advertising agencies (Bettini *et al.*, 2009). This will allow the advertising agencies to track and follow the user and to use more aggressive and unwanted marketing strategies. The third kind of harm an attacker can inflict on a user is to stalk the user (Bettini *et al.*, 2009; Fusco *et al.*, 2010; Cleveland, 2012). This can lead to unwanted conduct or even kidnapping by the attacker. A fourth type of harm that can be inflicted on the user is that of identity theft (Sweatt *et al.*, 2014). This is where an attacker will observe and follow a user to learn how to become the user and to finally steal the user's identity. A fifth example is an attacker who asserts himself/herself in the user's life (Cleveland, 2012). This leads to the attacker tracking the user and gathering personal information about the user, such as medical condition and political aspirations (Cleveland, 2012). The last example is where an attacker can do financial harm to the user (Haynes & Robinson, 2015). This example is usually caused by identity theft (Haynes & Robinson, 2015). The attacker will steal the user's identity and use the user's credit cards and financial information to make purchases as the user, with no intention of paying (Haynes & Robinson, 2015).

A study that focused on exploiting three of the most popular location-based applications' security flaws indicated that the industrial best practices for location-based privacy is not adequate (Li *et al.*, 2014a). This study was able to use different attacks to gain access to the users' top five locations (Li *et al.*, 2014a). This study also urges the public to be fully aware of the potential risks of location-based services (Li *et al.*, 2014a).

As can be seen, research has been conducted in the field of location-based technology, services, games and security. There has also been extensive research conducted in the security field of location-based technologies, services and games. Most of the security research focuses on the different types of attack, defence mechanism and harm that can befall a user. However, to the best of the researcher's knowledge, there are no studies that measure whether the use of these technologies, services and games increases the security awareness of a user or not. For this reason, the relationship between security awareness and the users and non-users of location-based technology, services and games will be determined in this phase. Furthermore, it is also important to increase the security awareness of users who use location-based technologies, services and games, as they may be unaware that they are using them or what the implications can be if their location data is

compromised. By increasing the security awareness, users can also obtain the necessary skills to prevent location-based data from being compromised.

3.4. Application of research method

3.4.1. The security awareness questionnaire

The on-line questionnaire was developed by the researcher and posted internally on the university intranet. In Table 3-1 the research objectives, information required to achieve the research objective, question type and format and reference are given. This table explains how the questionnaire was developed and from where the information on the questionnaire was gathered. The questionnaire consisted of three sections that intuitively showed and hid questions based on previous answers selected. This forestalled confusion and time wasted on irrelevant questions that participants would not be able to answer. It also limited the time spent on completing the questionnaire.

Table 3-1: The development of the questionnaire for the security awareness survey

Research Objective	Information require / research variables	Question type and format	Reference
Location-based devices	Frequency of using location-based devices	Question Type: List Question Format: Likert scale	List was assembled by using popular media platforms that cater for consumers.
Location-based services	Frequency of using location-based services and software Frequency of using certain internet locations	Question Type: List Question Format: Likert scale	List was assembled by using popular media platforms that cater for consumers.

Research Objective	Information require / research variables	Question type and format	Reference
Location-based games	Time spent playing games Frequency of using games services Frequency of playing on-line computer game genres Amount of money spent on computer games Frequency of playing off-line mobile game genres Frequency of playing on-line mobile game genres Amount of money spent on mobile games	Question Type: List Question Format: Likert scale	List was assembled by using popular media platforms that cater for consumers.
Security awareness	Frequency of monitoring location-based application Frequency of monitoring location-based games	Question Type: List Question Format: Likert scale The reliability test for the factor analysis for these two	(Barkhuus & Dey, 2003; Mokbel, 2007).

Research Objective	Information require / research variables	Question type and format	Reference
		research variables indicated that they should be interpreted as two separate variables.	
	Is location data sensitive? Can compromised location data be harmful? How important Is location-based security awareness.	Question Type: List Question Format: Likert scale Through using factor analysis and a reliability test, these research variables were combined and created the security awareness variable: Cautiousness of security implications	(Bettini *et al.*, 2009; Krumm, 2009; Fusco *et al.*, 2010; Peddinti *et al.*, 2011; Cleveland, 2012; Sweatt *et al.*, 2014; Wernke *et al.*, 2014; Haynes & Robinson, 2015).

The questionnaire consisted of three sections, each focusing on a specific topic. In the first section demographic information was requested. The demographic information included information on the computer science students' educational levels, work-related detail, levels of technological competence and experience, as well as adeptness at games. In the second section information regarding the participants' use and playing habits of mobile location-based technologies and games was required. In the third section questions regarding the awareness of the security risks in location-based services, technologies and games, as well as the implications should location-based data be compromised were presented. The questionnaire consisted of sixty-three questions in total and took approximately twenty minutes to complete. The questionnaire was set in English. After the data was gathered different statistical analyses were done. The statistical analyses that were used are factor analysis and independent t-tests.

In section three of the questionnaire the questions that measured the participants' security awareness with regard to mobile location-based games, technologies and services were posed. The last research variable, namely security awareness, will be deduced from these research questions. In order to reduce the dataset, factor analysis was used to group some of the security awareness variables together. The factor analysis techniques that were used to group the variables together were maximum likelihood combined with varimax rotation. These techniques will only be applied to the continuous variables (Likert scale). Matlab was used to do the factor analysis. Based on the results of the factor analysis the security awareness variables were determined as follows: frequency of monitoring applications that use location-based data (by turning off their location capabilities), frequency of monitoring games that use location-based data (by turning off their location capabilities) and cautiousness of security implications. The complete questionnaire is available in **Appendix 1**.

3.5. Results of analysing the security awareness survey

The detailed description of the survey and research method was given in Chapter 2. The research variables, as well as their research questions, research items, and descriptive statistics are depicted in Table 3-2, Table 3-3 and Table 3-4. Each of the research questions consisted of different research items that measured the research question. For example, to be thorough, a participant would have been asked to indicate the frequency of playing a specific off-line mobile game genre rather than just asking the participant whether he/she plays off-line mobile games.

3.5.1. Descriptive statistics

The first sub-objective of this phase was to determine whether or not using mobile location-based technology increased the security awareness of the participant. To establish this relationship, the research variables location-based devices and location-based services in Table 3-2 were used. The items of each research variable were measured on a Likert scale of five. The options for the five-point Likert scale included: never (represented by a 0), rarely (represented by a 1), seldom (represented by a 2), often (represented by a 3), and always (represented by a 4). This measured the frequency with which the participant used certain mobile location-based technologies and services. The Likert scale item "never" represents the participants who never use location-based devices and services. The rest of the Likert scale items represent the participants who indicated that they do use location-based devices and services and also the frequency of use. Windows Desktops is the device that was used the most with only 40 participants indicating never using it and the rest of the participants

using it with a frequency distribution of: rarely 0, seldom 6, often 41 and always 156. The technology device that the participants used the least was PlayStation Move with 239 indicating never using it and the rest of the participants using it with a frequency distribution of: rarely 1, seldom 3, often 0 and always 0. The same scale was used in respect of location-based services where SMS was the technology service and software which the participants used the most with only 43 indicating never using it. The rest of the participants indicated that they use SMS with a frequency distribution of, rarely 5, seldom 84, often 78 and always 33. The Internet location that the participants indicated they used the least was Internet at work with 214 participants indicating never using it. The participants who indicated that they do use Internet at work had the following frequency distribution: rarely 0, seldom 21, often 8 and always 20.

Table 3-2: Location-based devices and services variables

Research Variable	Research Question	Research Items	Never (0)	Rarely (1)	Seldom (2)	Often (3)	Always (4)	Measurement	Mean	SD
Location-based devices								17 Items		
	Technology Devices							17 Items		
		GPS	113	9	53	60	8		1.35	1.36
		Cell Phone	99	0	4	26	114		2.23	1.89
		Android Phone	143	0	1	14	85		1.58	1.91
		iPhone	217	0	2	4	20		0.4	1.16
		Windows Phone	234	1	0	0	8		0.14	0.72
		Android Tablet	213	1	3	11	15		0.41	1.13
		iPad	193	0	9	17	24		0.68	1.38
		Windows Tablet	241	1	0	1	0		0.01	1.20
		Windows Desktop	40	0	6	41	156		3.12	1.46
		Mac Desktop	235	0	0	6	2		0.11	0.59
		Linux Desktop	228	1	7	6	1		0.15	0.62
		XBox	196	4	23	13	7		0.48	0.47
		XBox Kinect	237	2	1	0	3		0.06	0.47
		PlayStation 2 and 3	184	12	28	14	5		0.53	1.04
		PlayStation Move	239	3	1	0	0		0.03	0.23
		Wii	226	5	11	1	0		0.12	0.47
		PSP	225	8	6	3	1		0.14	0.54
Location-based services								10 Items		
	Technology service and software							5 Items		
		SMS	43	5	84	78	33		2.22	1.25
		MMS	203	13	15	8	4		0.24	0.86
		BBM	117	1	7	26	92		1.9	1.89
		iMessage	205	1	10	11	16		0.49	1.18
		e-mail	85	7	32	80	39		1.92	1.55
		WhatsApp	20	2	13	69	139		3.26	1.16
	Internet Location							5 Items		
		Internet Home	44	0	21	67	111		2.82	1.47
		Internet Work	214	0	1	8	20		0.44	1.2
		Internet University	28	0	16	75	124		3.1	1.2
		Internet Mobile	57	3	28	78	77		2.47	1.53
		Internet Hotspot	131	3	17	46	46		1.48	1.69

The next research variable, location-based games, was used to achieve the second sub-objective of the study, namely to determine the effect of playing location-based games on security awareness. The dimensions used to measure this research variable are presented in Table 3-3 and are: time spent playing games, game services, on-line computer game genres, money spent on computer games, off-line mobile game genres, on-line mobile game genres, money spent on mobile games. These research variables were also on the same five-point Likert scale. Table 3-3 reports the results in the same way as Table 3-2 with Strategy as the on-line mobile game genre that the participants played the most and with 233 participants indicating never playing this genre. The rest of the participants indicated that they do play this genre with a frequency distribution of: rarely 1, seldom 2, often 3 and always 4. The on-line computer game genre that the participants played the least was educational games with 241 indicating that they never play this genre. The participants who do play this genre had a frequency distribution of: rarely 0, seldom 0, often 1 and always 1.

Table 3-3: Location-based games variables

Research Variable	Research Question	Research Items	Never (0)	Rarely (1)	Seldom (2)	Often (3)	Always (4)	Measure-ment	Mean	SD
Location-based games								41 Items		
	♣ Time spent playing games							3 Items		
		Hours Play Mobile games	69	80	66	16	12		1.27	1.1
		Hours Play Computer games	138	47	39	13	6		1.88	1.38
		Free time playing all games	149	62	22	10	0		0.56	0.82
	Game services							7 Items		
		Battle.net	190	6	17	11	19		0.61	1.26
		Wii	237	1	3	1	1		0.06	0.39
		Origin	212	6	9	11	5		0.32	0.90
		PlayStation Network	215	4	12	9	3		0.28	0.82
		Steam	155	13	18	33	24		1	1.47
		Windows Live	190	14	23	13	3		0.46	0.95
		XBox Live	212	5	11	11	4			
	On-line Computer game genres							8 Items		
		Action Adventure	226	5	3	6	3		0.17	0.68
		Shooter	177	4	21	18	23		0.79	1.39
		Role Playing Game (RPG)	225	0	4	8	6		0.24	0.84
		Massive Multiplayer Online Role Playing Game (MMORPG)	207	2	11	8	15		0.44	1.31
		Simulation	235	0	2	5	1		0.09	0.05
		Strategy	208	1	10	13	11		0.42	1.09
		Board game	239	0	2	2	0		0.04	1.32
		Educational Game	241	0	0	1	1		0.02	0.32
	Money spent on computer games							5 Items		
		Buy In Store	144	53	28	9	9		0.71	1.05
		Buy Online	203	29	8	1	2		0.23	0.61
		Buy Downloadable Content	196	36	6	2	3		0.45	0.93
		Buy Special Edition	203	2	14	18	6		0.27	0.67
		Pre-order Games	212	6	7	12	6		0.44	1.05
	Off-line mobile game genres							7 Items		
		Action Adventure	207	2	11	15	8		0.42	1.05
		Shooter	229	0	5	3	6		0.18	0.75
		Role Playing Game (RPG)	242	0	0	0	1		0.02	0.26
		Simulation	227	0	3	8	5		0.21	0.8
		Strategy	205	1	15	15	7		0.43	1.04
		Board game	220	1	10	8	4		0.25	0.82
		Educational Game	231	1	4	3	4		0.14	0.65
	On-line mobile game genres							8 Items		
		Action Adventure	236	0	2	2	3		0.09	0.54
		Shooter	239	0	1	1	2		0.05	0.42
		Role Playing Game (RPG)	242	0	0	1	0		0.01	0.19
		Massive Multiplayer Online Role Playing Game (MMORPG)	239	0	1	1	2		0.05	0.42
		Simulation	238	0	1	1	3		0.7	0.5
		Strategy	233	1	2	3	4		0.12	0.63
		Board game	238	0	0	1	4		0.08	0.54
		Educational Game	240	0	1	0	2		0.04	0.38
	♦ Money spent on mobile games							3 Items		
		Buy Downloadable Content	228	13	2	0	0		0.13	0.44
		Buy Online	218	22	1	1	1		0.07	0.29
		Buy Special Edition	160	66	9	0	8		0.07	0.29

♣ Likert Scale: Under 1 hour (0), 1-5 hours (1), 6-10 hours (2), 11-15 hours (3), more than 15 hours (4)
♦ Likert Scale: R0-R500 (0), R501-R1000 (1), R1001-R1500 (2), R1501-R2000 (3), more than R2000 (4)

The final research variable, security awareness, is given in Table 3-4 and was also on a five-point Likert scale, although two different five-point Likert scales were used. The first Likert scale was the same as for the other two research variables whereas the second scale included the following options: strongly disagree (represented by 0), disagree (represented by 1), neutral (represented by 2), agree (represented by 3), strongly agree (represented by 4). Frequency of monitoring location-based applications was on the same Likert scale with

186 of the participants indicating never using these applications. The rest of the participants indicated that they do monitor location-based applications with a frequency distribution of: rarely 4, seldom 17 often 21 and always 15. Frequency of monitoring location-based games was also on the same scale and indicated that 235 participants never monitor location-based games. The rest of the participants indicated that they do monitor location-based games with a frequency distribution of: rarely 1, seldom 1, often 4, always 2. Location data is sensitive was on the second Likert scale mentioned. The participants who indicated that they strongly disagree that location data is sensitive numbered 4. The rest of the participants indicated that location data is sensitive with the following distribution: disagree 3, neutral 27, agree 97 and strongly agree 115. Furthermore, only 6 participants indicated that they strongly disagree with the importance of location-based security awareness. The rest of the participants indicated that they agree with the importance of location-based security awareness with the following distribution: disagree 4, neutral 9, agree 115 and strongly agree 109.

Table 3-4: Security awareness variables

Research Variable	Question number	Research Question	Never (0)	Rarely (1)	Seldom (2)	Often (3)	Always (4)	Measurement	Mean	SD
Security awareness								5 Items		
	1.	Frequency of monitoring location-based applications (turning location capabilities off for location-based applications)	186	4	17	21	15		0.66	1.28
	2.	Frequency of monitoring location-based games (turning location capabilities off for location-based games)	235	1	1	4	2		0.09	1.54
			Strongly Disagree (0)	Disagree (1)	Neutral (2)	Agree (3)	Strongly Agree (4)			
	3.	Location data sensitive	4	3	24	97	115		3.3	0.83
	4.	Is compromised location data harmful	6	4	57	107	69		2.94	0.9
	5.	Importance of location-based security awareness	6	4	9	115	109		2.94	0.9

The gender of the participants was predominantly male. The ratio between male and female was: 80% male and 20% female. This gender distribution concurs with the general perception that more males are inclined to study computer science than females. The total number of males who participated in the questionnaire was 195, compared to a mere 48 females. The age range of the participants was as follows: 84% of the participants ranged between the ages of 18 and 21 and 15% between the ages of 22 and 25. The remainder of the participants was 25 years old and older.

3.5.2. Factor analysis

In section three of the questionnaire the questions that measured the participants' security awareness with regard to mobile location-based games, technologies and services were posed.

In order to reduce the dataset, factor analysis was used to group some of the security awareness variables together. The factor analysis technique that was used to group the variables together was maximum likelihood combined with varimax rotation (orthogonal rotation). Maximum likelihood allows the collection of some data and then allows the creation of a model for which the probability of the data is maximised (Field, 2009:690). This model can then be used to compare the probability of obtaining the data under the null hypothesis (Field, 2009:690). The resulting statistics are based on the comparison of the frequency of the observed data with the those of the model (Field, 2009:690). Varimax rotation attempts to maximize the dispersion of loading within the factors (Field, 2009:644). Therefore, varimax tries to load a smaller number of variables onto each factor resulting in the factors to be more interpretable (Field, 2009:644). This technique will only be applied to the continuous variables (Likert scale). Matlab was used to do factor analysis.

Table 3-5 depicts the factor-loading table after applying the factor analysis on the security awareness variables. The results of the factor analysis in Table 3-5 depict that the security awareness variables were grouped into two factors. An item was grouped in a factor where its factor loading was the highest. For example, question 1 in Table 3-5 had a factor loading value of -0.1580 for Factor 1 and 0.9849 for Factor 2. This resulted in question 1 being grouped into Factor 2.

Table 3-5: Factor loading for security awareness variables

Question number (Table 3-4)	Question	Factor 1	Factor 2
1.	Frequency of monitoring location-based applications (turning location capabilities off for location-based applications)	-0.1580	**0.9849**
2.	Frequency of monitoring location-based games (turning location capabilities off for location-based games)	0.0113	**0.2858**
3.	Location data sensitive	**0.8211**	-0.0905
4.	Is compromised location data harmful	**0.7953**	-0.0259
5.	Importance of location-based security awareness	**0.5591**	0.0157

Cronbach's alpha was used to measure the reliability between the items in each factor (Field, 2009:674). Cronbach's alpha is the most common measure to determine the reliability of factor analysis (Field, 2009:674). This measure is loosely equivalent to splitting the data into two groups in every possible scenario and computing the correlation coefficient for each

split (Field, 2009:674). The average of these values is called the Cronbach's alpha. An acceptable value for a Cronbach's alpha not to disband the factor into its individual items is 0.8 and higher (Field, 2009:675-676).

As mentioned, the factor analysis yielded two factors for the security awareness variables. Factor one evolved from the security awareness variables three, four and five, as is clearly depicted in Table 3-5. Factor one was labelled "Cautiousness of security implications" and proved to be reliable with a Cronbach's alpha of 0.86.

Table 3-5 shows that the second factor consisted of security awareness variables one and two. The second factor was labelled "Review concerning security features". Although the factor analysis grouped these security awareness variables for this factor, a Cronbach's alpha of 0.21 was yielded. Because the Cronbach's alpha value for the second factor was lower than 0.8, the factor structure will not be used and the individual items will be used. Thus the security awareness variables are: frequency of monitoring applications that use location-based data (by turning off their location capabilities), frequency of monitoring games that use location-based data (by turning off their location capabilities) and cautiousness of security implications.

3.5.3. Independent t-test

Independent t-tests were used to determine if there is a difference in the security awareness between the participants that use and participants that do not use the specific research item (Ellis & Steyn, 2003; Field, 2009:334-343). The statistical analysis was done in SPSS. The independent t-test was chosen as it allows the comparison of two means from different group entities (Ellis & Steyn, 2003; Field, 2009:334-343). With this analysis it is also possible to determine the mean of each of the groups in the comparison (Ellis & Steyn, 2003; Field, 2009:334-343). Table 3-6 through to Table 3-14 shows the results of the independent t-test. The analyses were done for each of the research items.

Two groups were identified for the independent t-test namely Non-users and Users. All of the participants that indicated they never use an item on the Likert scale was grouped into the Non-user group for that specific item. The rest were grouped into the User group. For a research item to be included in the analysis, either one of the two groups (Non-User, User) must have had a minimum of twenty participants in the group (Ellis & Steyn, 2003; Field, 2009:334-343). As the total participants in the group are 243, twenty was the minimum representation to represent a group (Ellis & Steyn, 2003; Field, 2009:334-343). The research items can be seen in the left-hand corner of each of the results sets that are grouped in Table 3-6 to Table 3-14. The security awareness variables are indicated to the left of each of

the results sets, as well as the group. Each of the result sets indicates the difference between each of the three security awareness variables, as well as the research variable. The columns in the table have the following meaning:

1. N - is the number of participants in each group for the specific awareness variable.
2. Mean – is the average that each group scored for the specific security awareness variable. The larger the value of the mean the more aware the group is of security awareness. The means will be interred in this phase.
3. Std. Deviation – indicates the standard deviation each group had for the specific security variable.
4. p-value – represents the statistical significance of the analysis for the difference between the two groups for each security awareness variable. The p-value will be reported for the sake of completeness but not interpreted, since a convenience sample was used instead of a random sample.
5. Effect size – indicates the difference between the means of each group for each security awareness variable. The value of 0.2 indicates a small difference between the groups and is indicated in the results in *italics*. An effect size of 0.5 indicates a medium difference between the two groups indicated in **bold** and 0.8 indicates a large difference indicated in **bold** and a ***** following the value. The effect size will be interpreted for the purpose of this phase. Only effect sizes that were larger than 0.2 will be shown. The reason for this is that results and effect size larger than 0.2 are meaningful and can be interpreted. The comprehensive list of results is shown in **Appendix 1**.

3.5.4. Location-based devices

3.5.4.1. Technology devices

The use of technology devices was measured by selecting 17 of the most popular technology devices that use location-based technologies. The aim of the analysis was to determine which of these devices leads to an increased security awareness.

Table 3-6 depicts the results of the independent t-test for technology devices and the three security awareness variables. The effect sizes in the table that can be highlighted as having a small difference between the user and non-user groups are: GPS for security awareness variable Cautiousness of security implications, Cell Phone for security awareness variable Cautiousness of security implications, iPhone for security awareness variable Cautiousness of security implications, iPad for security awareness variable Frequency of monitoring location-based games and Xbox for Frequency of monitoring location-based applications.

The only effect size that had a medium difference was iPhone for security awareness variable Frequency of monitoring location-based applications.

Table 3-6: Technology devices' t-test

GPS		N	Mean	Std. Deviation	p-value	Effect size
Cautiousness of security implications	Non-User	113	3.03	0.83	0.00	*0.35*
	User	130	3.32	0.57	0.00	
Cell Phone						
Cautiousness of security implications	Non-User	99	3.05	0.71	0.02	*0.30*
	User	144	3.27	0.70	0.02	
iPhone						
Frequency of monitoring location-based applications	Non-User	217	0.56	1.15	0.00	**0.53**
	User	26	1.54	1.86	0.01	
Cautiousness of security implications	Non-User	217	3.22	0.65	0.02	*0.33*
	User	26	2.87	1.07	0.12	
iPad						
Frequency of monitoring location-based games	Non-User	193	0.06	0.40	0.03	*0.20*
	User	50	0.24	0.89	0.16	
Windows Desktop						
Frequency of monitoring location-based games	Non-User	40	0.00	0.00	0.23	0.19
	User	203	0.11	0.59	0.01	
Xbox						
Frequency of monitoring location-based applications	Non-User	196	0.60	1.22	0.10	*0.23*
	User	47	0.94	1.47	0.15	

3.5.5. Location-based services and software

3.5.5.1. Technology service

The technology services that were selected are the most popular services that are able to make use of location-based service. The aim of this analysis was to determine which of these services leads to an increased security awareness. The results for the independent t-tests between technology services and the security awareness factors are presented in Table 3-7.

Table 3-7: Technology Services' t-test

SMS		N	Mean	Std. Deviation	p-value	Effect size
Cautiousness of security implications	Non-User	43	3.02	0.91	0.09	*0.22*
	User	200	3.22	0.66	0.17	
MMS						
Frequency of monitoring location-based applications	Non-User	203	0.60	1.22	0.09	*0.25*
	User	40	0.98	1.51	0.15	
iMessage						
Frequency of monitoring location-based applications	Non-User	205	0.59	1.20	0.04	*0.29*
	User	38	1.05	1.61	0.10	
e-mail						
Frequency of monitoring location-based applications	Non-User	85	0.35	0.98	0.01	*0.34*
	User	158	0.83	1.38	0.00	
Cautiousness of security implications	Non-User	85	3.06	0.91	0.06	*0.20*
	User	158	3.25	0.57	0.09	
WhatsApp						
Frequency of monitoring location-based applications	Non-User	20	0.15	0.67	0.06	**0.43**
	User	223	0.71	1.31	0.00	

The effect sizes that can be highlighted with a small difference are: SMS and security awareness variable Cautiousness of security implications, MMS for security awareness variable Frequency of monitoring location-based application, iMessage for security variable monitoring location-based applications, and e-mail for security awareness variables Frequency of monitoring location-based applications and Cautiousness of security implications. The only effect size that had a medium difference was WhatsApp for the security awareness variable Frequency of monitoring location-based applications.

3.5.5.2. Internet location

Various dimensions of Internet location were measured, namely Internet at home, at university, on mobile and at a hotspot. The results for the independent t-tests between Internet location and the security awareness factors are shown in Table 3-8.

Table 3-8: Internet location's t-test

Internet Work		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based applications	Non-User	214	0.61	1.22	0.10	*0.27*
	User	29	1.03	1.59	0.18	
Cautiousness of security implications	Non-User	214	3.16	0.73	0.26	*0.22*
	User	29	3.32	0.55	0.17	
Internet University						
Frequency of monitoring location-based applications	Non-User	28	0.00	0.00	0.00	**0.56**
	User	215	0.75	1.33	0.00	
Cautiousness of security implications	Non-User	28	2.92	1.20	0.04	*0.25*
	User	215	3.22	0.62	0.20	
Internet Mobile						
Frequency of monitoring location-based applications	Non-User	57	0.32	0.95	0.02	*0.34*
	User	186	0.77	1.35	0.01	
Internet Hotspot						
Frequency of monitoring location-based applications	Non-User	131	0.48	1.10	0.02	*0.28*
	User	112	0.88	1.43	0.02	

The effect sizes that can be highlighted with a small difference between the groups are: Internet Work for the security awareness variables Frequency of monitoring location-based applications and Cautiousness of security implications, Internet university for the security awareness variable Cautiousness of security implications, Internet mobile for security awareness variable Frequency of monitoring location-based applications and Internet hotspot for the security awareness variable Frequency of monitoring location-based applications. The only effect size that had a medium difference was Internet University for the security awareness variable Frequency of monitoring location-based applications.

3.5.6. Location-based games

3.5.6.1. Gaming services

The gaming services were measured by selecting seven of the most popular gaming services that are able to use location-based services. The aim of the analysis was to determine which of these services leads to an increase in security awareness. The results for the independent t-tests are given in Table 3-9.

Table 3-9: Gaming services t-test

Windows Live		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based games	Non-User	190	0.04	0.34	0.00	*0.25*
	User	53	0.28	0.95	0.07	
Cautiousness of security implications	Non-User	190	3.15	0.75	0.17	*0.20*
	User	53	3.30	0.55	0.10	
Xbox Live						
Cautiousness of security implications	Non-User	212	3.15	0.73	0.09	*0.32*
	User	31	3.39	0.53	0.03	

The effect sizes that can be highlighted with a small difference between the groups are: Windows Live for the security awareness variables Frequency of monitoring location-based

games and Cautiousness of security implications and Xbox Live for the security awareness variable Cautiousness of security implications.

3.5.6.2. On-line computer game genres

The on-line computer game genres were measured by choosing 11 of the most popular on-line computer genres. The aim of this analysis was to determine whether or not playing any of these game genres increased security awareness. The results of the independent t-tests can be seen in Table 3-10.

Table 3-10: On-line computer game genres t-test

Shooter		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based games	Non-User	177	0.03	0.28	0.00	*0.24*
	User	66	0.26	0.92	0.06	
Strategy						
Frequency of monitoring location-based games	Non-User	208	0.07	0.47	0.05	*0.22*
	User	35	0.26	0.85	0.21	

The effect sizes that can be highlighted with a small difference between the groups are: Shooter for the security awareness variable Frequency of monitoring location-based games and Strategy for the security awareness variable Frequency of monitoring location-based games.

3.5.6.3. Money spent on computer games

To be able to measure money spent on computer games, the following dimensions were included: Buy in store, buy on-line, buy downloadable content, buy special edition and pre-order games. The results for the independent t-test can be seen in Table 3-11.

Table 3-11: Money spent on computer games t-test

Buy Downloadable Content		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based games	Non-User	196	0.05	0.39	0.01	*0.24*
	User	47	0.28	0.93	0.11	
Buy Special Edition						
Frequency of monitoring location-based applications	Non-User	203	0.72	1.32	0.09	*0.28*
	User	40	0.35	0.98	0.04	
Buy Pre-order Games						
Frequency of monitoring location-based games	Non-User	212	0.07	0.46	0.03	*0.25*
	User	31	0.29	0.90	0.18	

The effect sizes that can be highlighted with a small difference between the groups are: Buy downloadable content for the security awareness variable Frequency of monitoring location-based applications, Buy special edition for monitoring location-based applications and Buy pre-order games for the security awareness variable Frequency of monitoring location-based games.

3.5.6.4. Off-line mobile game genres

Off-line mobile game genres were measured by choosing eight of the most popular off-line mobile game genres. The aim of this analysis was to determine whether or not playing any of these game genres increased security awareness. The results for the independent t-tests are presented in Table 3-12.

Table 3-12: Mobile off-line game genres t-test

Action Adventure		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based applications	Non-User	207	0.56	1.18	0.00	**0.42**
	User	36	1.25	1.65	0.02	
Frequency of monitoring location-based games	Non-User	207	0.06	0.39	0.01	*0.24*
	User	36	0.31	1.04	0.17	
Board Games						
Frequency of monitoring location-based games	Non-User	220	0.07	0.46	0.05	*0.23*
	User	23	0.30	1.02	0.29	

The effect sizes that can be highlighted with a small difference between the groups are: Action adventure for the security awareness variable Frequency of monitoring location-based games and Board games for the security awareness variable Frequency of monitoring location-based games. The only effect size that had a medium difference between the groups was Action adventure for the security awareness variable Frequency of monitoring location-based applications.

3.5.6.5. Money spent on mobile games

To be able to measure money spent on computer games, the following dimensions were included: Buy downloadable content, buy on-line and buy special. The results for the independent t-tests can be seen in Table 3-13.

Table 3-13: Money spent on mobile games t-test

Buy Downloadable Content		N	Mean	Std. Deviation	p-value	Effect size
Frequency of monitoring location-based games	Non-User	218	0.07	0.46	0.03	*0.25*
	User	25	0.32	0.99	0.22	
Cautiousness of security implications	Non-User	218	3.17	0.73	0.31	*0.21*
	User	25	3.32	0.55	0.21	
Buy Special Edition						
Cautiousness of security implications	Non-User	160	3.13	0.78	0.11	*0.20*
	User	83	3.29	0.54	0.07	

The effect sizes that can be highlighted with a small difference between the groups are: Buy downloadable content for the security awareness variables Frequency of monitoring location-based games and Cautiousness of security implications.

3.5.7. Security awareness variables

Most of the independent t-tests did not yield a large difference in the effect size. However, while the results were processed it was noted that the means of the security awareness variables Frequency of monitoring location-based applications and Frequency of monitoring location-based games were usually much lower than the security awareness variable Cautiousness of security implications. To have statistical proof of the difference between the security variables, dependent t-tests were done between Frequency of monitoring location-based applications, Frequency of monitoring location-based games and Cautiousness of security implications. The results for this analysis are interpreted in the same way as for the independent t-test. The results for these tests are given in Table 3-14.

Table 3-14: Security awareness comparisons t-test

Security Awareness Comparison		N	Mean	Std. Deviation	p-value	Effect size
Pair 1	Frequency of monitoring location-based applications	243	0.66	1.28	0.02	**1.97 ***
	Cautiousness of security implications	243	3.18	0.71		
Pair 2	Frequency of monitoring location-based games	243	0.09	0.54	0.97	**4.33 ***
	Cautiousness of security implications	243	3.18	0.71		

The effect sizes for both these tests indicate that there is a very large difference between the security awareness variable. The significance of this will be discussed in the Discussion of Results section.

3.6. Discussion of the security awareness survey results

In this section the results reported in the previous section will be interpreted and discussed. The focus will only be on effect sizes of the t-test that indicated at least a medium difference between users and non-users. The effect sizes that were marked in *italics* indicate a small effect size, **bold** indicates a medium effect size and bold with an asterisk (***bold**) indicates a large effect size in the above-mentioned tables. A summary of the results can be seen in Table 3-15. There were two major findings after analysing the data. The first was that the majority of the effect sizes between the users and non-users for location-based technologies, services and games were small. This indicates that there is not a significant difference between users and non-users for these items in regards to security awareness. The second finding is that the participants, although indicating that they are cautious of security implications, do not take preventative measures in securing themselves.

Table 3-15: Summary of results

Research Variables / Research Question	Security Awareness Factors		
	Frequency of monitoring applications that use location-based data	Frequency of monitoring games that use location-based data	Cautiousness of security implications
Location-based devices			
Technology Devices	**iPhone**; *Xbox*;	*iPad*;	*GPS*; *Cell Phone*; *iPhone*;
Location-based services			
Technology service and software	*MMS*; *iMessage*; *e-mail*; **WhatsApp**;	-	*SMS*; *e-mail*;
Internet Location	*Internet Work*; **Internet University**; *Internet Mobile*; *Internet Hotspot*;	-	*Internet Work*; *Internet University*;
Location-based games			
Game services	-	*Windows Live*;	*Windows Live*; *Xbox Live*;
On-line computer game genres	-	*Shooter*; *Strategy*;	-
Money spent on computer games	*Buy special edition*;	*Buy downloadable content*; *Buy pre-order games*;	-
Off-line mobile game genres	**Action Adventure**;	*Action Adventure*; *Board Games*;	-
On-line mobile game genres	-	-	-
Money spent on mobile games	-	*Buy downloadable content*;	*Buy downloadable content*;
Security Awareness Variables	***Cautiousness of security implications;**	***Cautiousness of security implications;**	-

3.6.1. Technology devices

iPhone had a medium effect size of 0.53 for the security awareness variable Frequency of monitoring applications that use location-based data. The non-users indicated with a mean of 0.56 that they never to rarely monitor location-based applications, whereas the users with a mean of 1.54 indicated that they rarely to seldom monitor the location-based applications on their iPhones. This can be because iOS (iPhone operating system) is developed to specifically ask the user to allow an application to use location-based data. This can make the computer science student more aware of applications that use location-based data. Furthermore, the iPhone is a popular smartphone and has access to many location-based games and applications on the iStore. iPhone also had a small to medium effect size of 0.33 for the security awareness variable Cautiousness of security implications. The users indicated with a mean of 2.87 that they are cautious of security implications, whereas the non-users with a mean of 3.22 (more strongly) indicate that they are cautious of security implications. This can be because iOS usually asks the user, before executing a tasks, for permission to use a location-based service, which can lead to the users trusting the technology more and not worrying about the security implications.

3.6.2. Technology services

WhatsApp had a medium effect size of 0.43 with the security variable Frequency of monitoring location-based applications. The non-users, with a mean of 0.15, never monitor location-based applications, whereas the users, with a mean of 0.71, never to rarely monitor location-based applications.

The reason for the difference between the non-user and user groups can be that the more technologically advanced the messaging service is the more likely the computer science students will notice applications that can use location-based data.

3.6.3. Internet location

Using the Internet at university had a medium effect size of 0.56 for the security awareness variable Frequency of monitoring location-based applications. The non-users indicated with a mean of 0.00 that they never monitor location-based applications, whereas the users indicated with a mean of 0.75 that the never to rarely monitor location-based applications. Using the Internet at university also had a small effect size of 0.25 with the security awareness variable Cautiousness of security implications. The non-users, with a mean of 2.92, indicate that they are cautious about security implications, whereas the users, with a mean of 3.22, (more strongly) indicate that they are cautious about security awareness.

The reason for these results can be that the computer science students become more aware of the security risk of connecting to an open Internet, such as the university's Wi-Fi, as their exposure to these networks increase.

3.6.4. Off-line mobile games

The offline mobile game Action Adventure had a medium effect size of 0.42 for the security awareness variable Frequency of monitoring location-based applications. The non-users indicated with a mean of 0.56 that they never to rarely monitor location-based applications, whereas the users indicated with a mean of 1.25 that they rarely too often monitor location-based applications. Off-line mobile game Action Adventure also had a small effect size of 0.24 with the security awareness variable Frequency of monitoring location-based games. The non-users indicated with a mean of 0.06 they never monitor location-based games, whereas users indicated with a mean of 0.31 that they never to rarely monitor location-based games.

The explanation for these results can be that off-line mobile games can also be able to determine the user's location by using GPS. Therefore, the experience computer science

students have in playing these game genres may also contribute to their knowledge about the location-based gaming domain.

3.6.5. Security awareness variables

Most of the means for the security awareness variable Cautiousness of security awareness were over 3.00. This means that the participants agree that they are cautious of security implications. The security awareness variables Frequency of monitoring location-based applications and Frequency of monitoring location-based games measure the preventative measures. The average mean for the security awareness variables was around 1.0. This indicates that they rarely implement these preventative measures. It could be argued that the more cautious about security the participants are the higher the preventative measures should be.

This is the reason for doing the dependant t-tests. It is to statistically show that the participants, although indicating that they are cautious of security implications do not take preventative steps.

Frequency of monitoring location-based applications had a very large effect size of 1.97 for the security awareness variable Cautiousness of security implication. The participants indicated with a mean of 3.18 that they are cautious of security implications, however, they indicated with a mean of 0.66 that they never to rarely monitor location-based applications.

Frequency of monitoring location-based games had a very large effect size of 4.33 for the security awareness variable Cautiousness of security implication. The participants indicated with a mean of 3.18 that they are cautious of security implications, however, they indicated with a mean of 0.09 that they never monitor location-based games.

This shows that the participants do not take preventative measures in spite of indicating that they are cautious of security awareness. The reason for this is unknown, but future studies could elaborate on this.

3.7. Summary

This phase of the development of the DMLBG focused on the security awareness and the use of location-based services, technologies and games. Two sub-objectives were set to be addressed in this phase, namely determine the effect of using mobile location-based technology and mobile location-based services on security awareness and determine the effect of playing location-based games on security awareness.

To achieve the first sub-objective, independent t-test results between mobile location-based technology usage and the security awareness variables were analysed. From these analyses it can be seen that the difference in the security awareness of computer science students who use some of these technologies and the computer science students that do not is not significant. This means that security awareness is not necessarily increased by using location-based technologies, services and games.

To achieve the second sub-objective, independent t-test results between location-based games and the security awareness variables were analysed. This analysis indicated that there was a difference between computer science students who played games and those who did not.

It was also found that the computer science students, although indicating that they are cautious of security implications, do not take precautions to enforce security measures. This is evident from the analysis of the dependent t-tests for the security awareness variables. In this analysis there was a very large difference in monitoring location-based applications and games (by turning off their location capabilities) and the cautiousness of security implications. Possible security incidences in this regard have become evident since Pokémon GO was released. The security incidences that happened to some of the players are amongst others: players have been robbed as the robbers could guess players locations based on where high numbers of the Pokémons can be found, a player was caught in a supposed drug deal, players not respecting personal property and trespassing to be able to capture Pokémons, stepping in front of traffic, the game accesses all personal Google account details if the player does not switch this function off and playing the game while driving and endangering other drivers (Akolawala, 2016; Arora, 2016; Lee, 2016; Lindh, 2016; Matyszczyk, 2016; Reuters, 2016; Schwartz, 2016; Summers, 2016). All the mentioned security issues need to be communicated to the players before playing to ensure that they are aware of the possible harm in playing these types of games. A summary of all the results is given in Table 3-15.

The next chapter will discuss the second phase of the development of the DMLBG, which focuses on the development of a framework to determine the suitability of SDMs for location-based game development. The results of this phase are incorporated in the next phase by ensuring that security is one of the aspects included in the development process of location-based games.

Chapter 4 The development of a framework to determine the suitability of SDMs for location-based game development

This phase of the study is based on the research paper: **The creation of a framework to determine the suitability of systems development methodologies for location-based games**. The paper was submitted to the journal: **Journal of Location Based Services**. Currently the status of the paper is: **Under Review**.

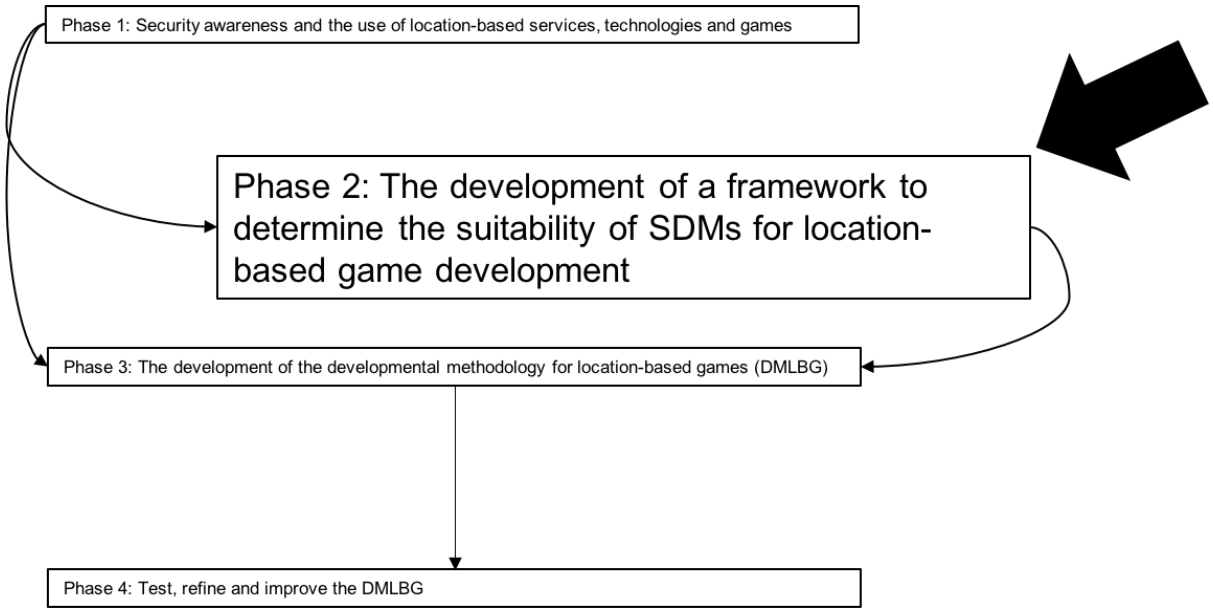


Figure 4-1: Research roadmap – phase 2

4.1. Introduction

According to gamesindustry.biz, the gaming industry is expected to reach 100 billion dollars worldwide by the year 2018 (Game Industry Biz, 2015). This was based on research conducted by a research company, DFC Intelligence (DFC Intelligence, 2015; Game Industry Biz, 2015). Furthermore, the company found that the mobile gaming market would grow from 10 billion dollars in 2013 to 29 billion dollars in 2018 (DFC Intelligence, 2015; Game Industry Biz, 2015). Another study conducted by Zackariasson and Wilson (2010) found that the growth in the gaming industry over the previous 25 years rose by between 9% and 15%. The study by Zackariasson and Wilson (2010) also indicates that the gaming industry is a rapidly expanding industry, even more so than the film industry. Two independent studies, one conducted by PwC (film revenue) and another by Bundesverband Musikindustrie (music revenue) elaborate on the growth of the music and film industries (Statista, 2013; PWC, 2015). In 2012 PwC found that the film industry would only grow by

3.1% between 2011 and 2016, with a revenue increase from 85 billion dollars to 98 billion dollars (PWC, 2015). Bundesverband Musikindustrie found that the music industry will grow by 13.4% between 2013 and 2018 and revenue will increase from 12.3 billion dollars to 13.9 billion dollars in 2019 (Statista, 2013). It is evident from these studies that the gaming industry is the fastest growing and also generates the most revenue amongst its entertainment competitors.

From 1998 to 2008 industrial game development has exponentially increased in complexity (Reyno & Cubel, 2008). One of the elements that contributes to the complexity of game development is the multidisciplinary development process (Callele *et al.*, 2005). Different specialist areas, such as art, gameplay, sound, control systems, and human factors interacting with traditional software development all indicate that a specialised software engineering methodology is needed for this domain (Callele *et al.*, 2005). Another element that leads to the complexity of game development is the technical challenges for the developers (Blow, 2004). Blow (2004) mentions a number of elements, such as tools, project size, workflow and other technical aspects that contribute to the complexity of game development.

As this study focuses on location-based games, it is important to define a location-based game. A location-based game is a type of ubigame that focuses on the player's location and incorporates it in the game play (Buzeto *et al.*, 2014). This is to allow the player to be more immersed in the game world were the magic happens (Buzeto *et al.*, 2014). Furthermore, location-based games are a type of mobile game and it is important to mention that the development of mobile games is just as complicated as console or on-line games (Feijoo *et al.*, 2012). This is due to the fact that the development of mobile games entails different aspects that are not included in the development of the other two previously mentioned games (Feijoo *et al.*, 2012).

Despite the rapid expansion of the gaming industry's expenses and complexity, there is still a need for SDMs to enhance the productivity in terms of quality, time and cost (Reyno & Cubel, 2008). Furthermore, the complex nature of the development process of games adds to the need for a specialised SDM (Callele *et al.*, 2005). The reason for the absence of SDMs in the gaming industry is that in the beginning games were developed by one person who did not need an entire SDM (Keith, 2010:6-7). As the gaming industry expanded and the technology became more complex, the lone programmer became reliant on large teams and other specialists (Keith, 2010:6-7). To reduce the risk of not completing the game due to the growing need of game development, most companies adopted the SDLC, also known as the

Waterfall model (Keith, 2010:6-9). Individual games developers rely on *ad hoc* development, agile development, component-based development and software product lines (Reyno & Cubel, 2008; Keith, 2010). There is a lack in SDMs that specifically address all the needs of the game development process, more specifically a lack of SDMs for the development of location-based games. Furthermore, ubigames make use of different and usually the latest hardware components that can be used to immerse the player in the gaming world. This leads to the software development of ubigames to lag behind the hardware development. This also leads to the lack of SDMs for these types of games. There is a variety of ubigames and to be able to determine whether or not an SDM can aid in their development is not possible without starting by focusing on one type of these games. Therefore, the framework in this phase (Figure 4-1) will be developed specifically for location-based games. This framework can become the baseline to develop other and more general frameworks to evaluate SDMs for ubigame development. It is not claimed that there are no SDMs specifically developed for location-based games, merely that the researcher is not aware of any. In this phase a framework that can be used to evaluate current SDMs to determine whether they are suitable for developing location-based games will be developed. The framework will enable location-based games developers to choose an SDM that is best suited for developing a location-based game. The analysis of multiple SDMs will also allow the researcher to develop a new SDM specifically designed for the development of location-based games.

In section 4.2 the sub-objectives of this phase will be addressed. In section 4.3 the necessary theoretical background, as well as the analysis needed to form the list of development aspects for this phase will be given. In section 4.4 the development and use of the framework will be described and in section 4.5 the results of this phase will be summarised.

4.2. Sub-objectives

In this phase a framework to evaluate the suitability of SDMs in aiding the developing of location-based games will be developed. As part of this process, the framework will also be tested by evaluating current SDMs. The following sub-objective were set to achieve this:

1. Define unique aspects that need to be addressed in the development process of location-based game development to determine the requirements for a new SDM.
2. Use a survey to gather information from the gaming industry to determine how important each aspect is and determine whether the study has failed to identify any aspects.

3. Develop a framework, based on the feedback from the industry that can be used to analyse SDMs to determine their suitability to aid in the development of location-based games.
4. Demonstrate the use of the framework by applying the framework to a few selected SDMs.

4.3. Theoretical background

Due to the evolution of mobile technology an explosion of new and creative games has been witnessed (Ardito *et al.*, 2010). Location-based games are one of these types of games that became a reality due to Smartphones that have advanced location-sensing capabilities, such as GPS (Ardito *et al.*, 2010). The development of a location-based game is complex process. For this reason, an SDM can aid in the development of location-based games. As previously stated, the researcher is not aware of any SDMs that specifically address all the aspects for developing a location-based game. In this phase some of the SDMs that are usually associated with the development of games and mobile applications will be discussed. These SDMs will be evaluated to determine their suitability for developing location-based games. Aspects that need to be addressed in the process of location-based game development will be identified by analysing the literature. One of the aspect, namely security and privacy, was identified in the previous phase. The results of this phase clearly show that participants do not take preventative measures when using location-based technologies, services and games. Due to this, it is important that the development process of location-based games emphasises secure development. The importance of each aspect will then be determined by using a questionnaire. The questionnaire will also allow games developers to add aspects that might have been over-looked. The features that a location-based game can have will also be identified by analysing the literature to provide an extended definition of a location-based game. The final list of aspects will be used to develop the framework for evaluating an SDM's suitability to aid in the development of location-based games.

4.3.1. Systems development methodologies

It is important to understand what SDMs are and how they work in order to develop a framework that can evaluate the suitability of an SDM. According to Avison and Fitzgerald (2006:24), an SDM can be defined as the totality of a systems development approach. To elaborate: an SDM is a set of recommended rules, processes and/or steps that need to be followed. Each of these forms part of the total development process that is usually governed by an underlying philosophy that supports, justifies and incorporates coherent context for a

specific development project (Avison & Fitzgerald, 2006:597-603). Furthermore, an SDM identifies the best procedures, phases, tools, techniques, rules, guidelines, documentation and tasks to be used for a specific development project, as well as the best manner to execute each of these (Avison & Fitzgerald, 2006:597-603). It may also incorporate organisation and managerial approaches for the identification and training of participants (Avison & Fitzgerald, 2006:597-603).

An SDM in itself consists of four main components, namely a philosophical approach, method, process model and tools and techniques (Avison & Fitzgerald, 2006:597-603; Huisman & Iivari, 2006). These components make it possible to evaluate, analyse, compare and develop SDMs. All of these components work together to achieve an integrated process with the objective of better utilising the development of systems (Avison & Fitzgerald, 2006:597-603). The philosophical approach defines the perspective through which the system is developed (Avison & Fitzgerald, 2006:597-603; Reyno & Cubel, 2008). In other words, the philosophical approach portrays the baseline or core purpose for which the SDM was developed (Avison & Fitzgerald, 2006:597-603; Huisman & Iivari, 2006). The next part of an SDM is the development method and consists of the steps that must be followed during the development process (Avison & Fitzgerald, 2006:597-603; Huisman & Iivari, 2006). These steps are executed as specified by the process model. The process model therefore dictates the strictness of execution, dependencies and iterations of the steps (Avison & Fitzgerald, 2006:597-603; Huisman & Iivari, 2006). Finally, the tools and techniques facilitate the development process (Avison & Fitzgerald, 2006:597-603; Huisman & Iivari, 2006).

As the focus in this phase will be on developing a framework for evaluating an SDM's suitability for the development of location-based games, an overview of each of the SDMs chosen for this phase will be given, as well as the evaluation of each SDM with regard to supporting each aspect of the location-based game development process. The results of the analysis of the aspects will be used to develop a framework for evaluating the suitability of the SDM. The SDMs that are chosen for the study are SDMs that are usually associated with game development, mobile development or mobile game development (Beynon-Davies & Holmes, 2002; Abrahamsson *et al.*, 2004; Hunicke *et al.*, 2004; Avison & Fitzgerald, 2006:22-30; Jeong *et al.*, 2008; Krall & Menzies, 2012). Furthermore, each SDM represents a different combination of philosophical approach, method, process and sets of tools and techniques to better represent SDMs that are used for these types of development. The SDMs that are going to be used and discussed in this study are: Traditional SDLC, Scrum, Mobile Application Software Based on Agile Methodology (MASAM), Mobile-D, Rapid

Application Development (RAD), Dynamic Systems Development Method (DSDM), Mechanics, Dynamics and Aesthetics framework (MDA), Playability and Re-playability and Player-Centred design.

4.3.1.1. Traditional Systems Development Life Cycle (Royce, 1970; DOJ, 2003; Avison & Fitzgerald, 2006:31-44)

The Traditional Systems Development Life Cycle (SDLC), also known as the Waterfall model was one of the first SDMs used to develop information systems. This SDM was later adapted and used to develop games. There have been many versions of the SDLC. The first version of the SDLC consisted of seven steps as shown in Figure 4-2.

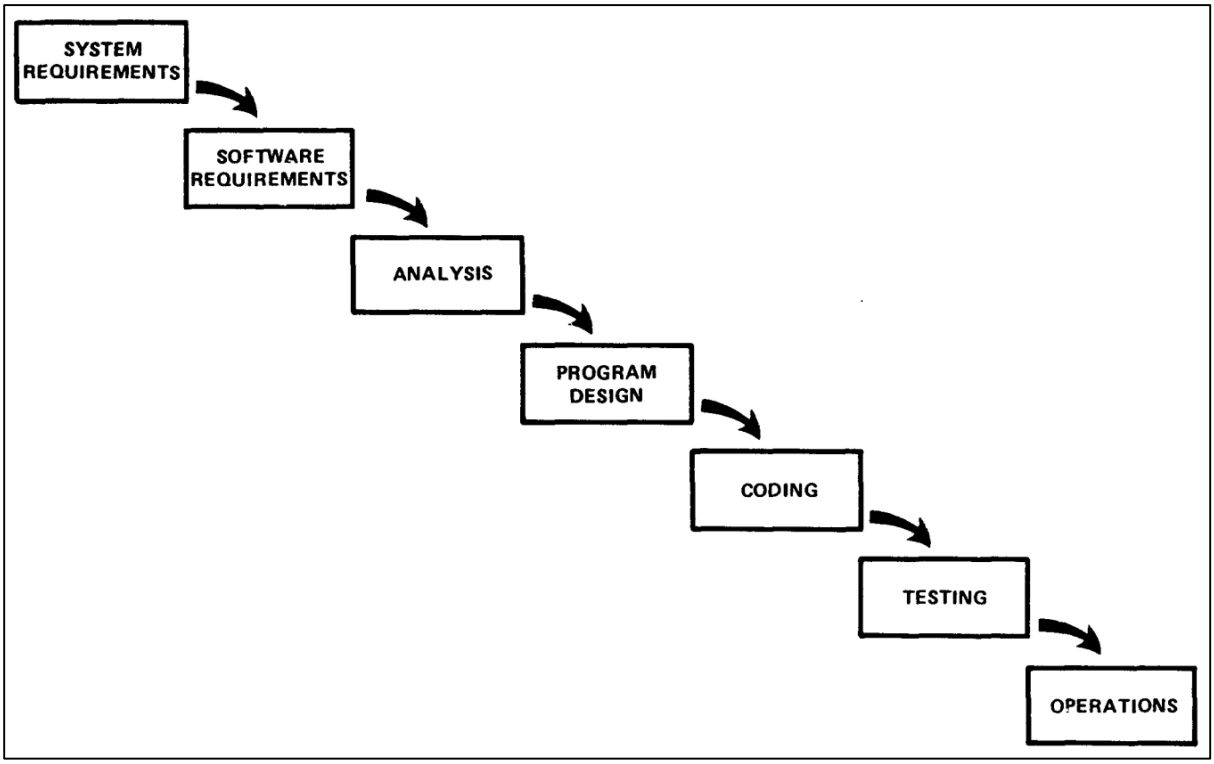


Figure 4-2: Earlier process model of the SDLC (Royce, 1970)

A later adaptation of the SDLC consisted of ten phases that are clearly defined and executed in sequence. A graphical representation of this process model can be seen in Figure 4-3. These phases are:

1. Initiation: In this phase, the needs for a certain project are identified.
2. System Concept Development: In this phase, the feasibility study for the project is conducted.
3. Planning: The implementation of the project in the business and how to ensure that the system meets business requirements are determined in this phase.

4. Requirement analysis: Requirements are defined.
5. Design: Physical characteristics are designed.
6. Development: Implementation of the specifications of the design phase.
7. Integration and Testing: The components are systematically tested.
8. Implementation: The system is integrated into the business.
9. Operations and Maintenance: The system is monitored to address necessary changes.
10. Disposition: This entails the correct termination of the previous system and the preservation of information concerning the previous system.

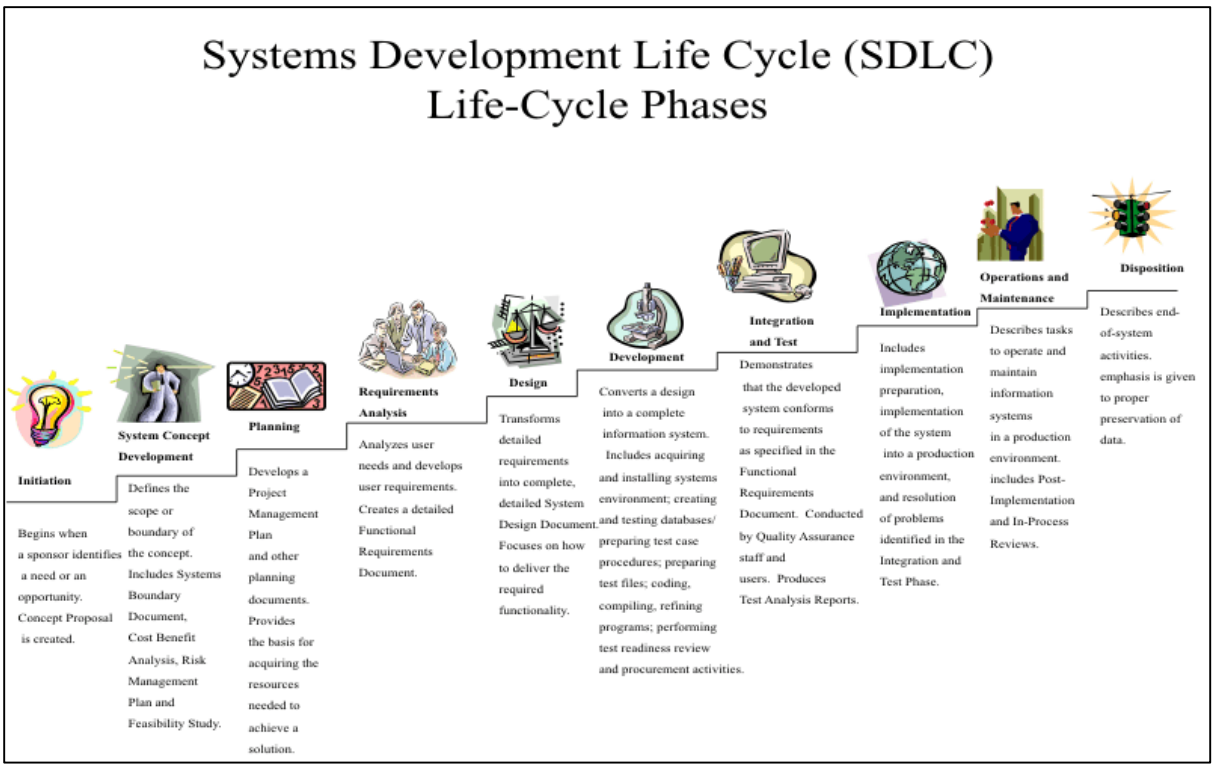


Figure 4-3: Process model of the then phase SDLC (DOJ, 2003)

In both versions of the SDLC that are mentioned, activities in each phase are clearly defined and executed rigorously. These SDLCs are therefore a systematic top-down (bottom-up for the 10 phase version) approach that follows a strict sequential execution with no iterations or adaptations allowed, as can be seen from Figure 4-2 and Figure 4-3.

The philosophy of the SDLC is that computer-based solutions are the best solution for a problem. Furthermore, it also emphasises a simple design for a solution. This forms the philosophy of the SDLC. The method of the SDLC consists of the different phases as previously mentioned. The process model that indicates the execution of the method for the SDLC determines that the phases for this SDM will be executed sequentially. The main tools

and techniques associated with this SDM are milestones, checklists and CASE (computer-aided software engineering) tools. The SDLC is an SDM because it contains all four of the main components of an SDM.

4.3.1.2. Scrum (Keith, 2010)

The Scrum framework is part of the agile development methodology family along with Extreme Programming and Feature Driven Development. These SDMs are exactly the opposite of the SDLC. The major difference is that Scrum focuses on practical applications and flexibility. To elaborate on these issues, Scrum was created to be a management and control tool to bypass complexity. Scrum also focuses on building software applications that will satisfy business requirements.

The initial assumption that Scrum makes is that a development process cannot be planned from the beginning to the end. This is because the scope of a project will most likely change or expand over time. Scrum therefore starts by allowing the creation of a prioritised list of features that is essential to the application. This list is called the product backlog. Scrum is divided into three levels of planning: release planning, sprint planning and the daily scrum.

During the release planning, the cost of the project and general functionality are discussed. Operational details are planned in an iterative fashion as the project moves forward. These iterations are called sprints and usually take a month to complete. The planning sessions mentioned are called sprint planning sessions. Tasks assigned in the sprint sessions are called sprint backlog. The last planning takes place on a daily basis and is called the daily scrum. In this planning phase each member involved in the development of the project reports on his/her progress and new tasks are assigned. The duration of these sessions is fifteen minutes on average. This cycle is repeated often enough so that milestones, product backlog progress, story tracking, budget and deadlines can be set.

Figure 4-4 depicts the process to follow when using Scrum. The backlog, as mentioned, is where all of the tasks that need to be completed for the entire duration of the project are kept in a specific priority. Each timeframe in which specific tasks need to be developed is called a sprint as can be seen in this figure. The length of a sprint can be different for each development team. The sprint backlog would be the task the development team committed to finish in the sprint. The end result of the sprint would be a small working snippet of the game that can be integrated into the project.

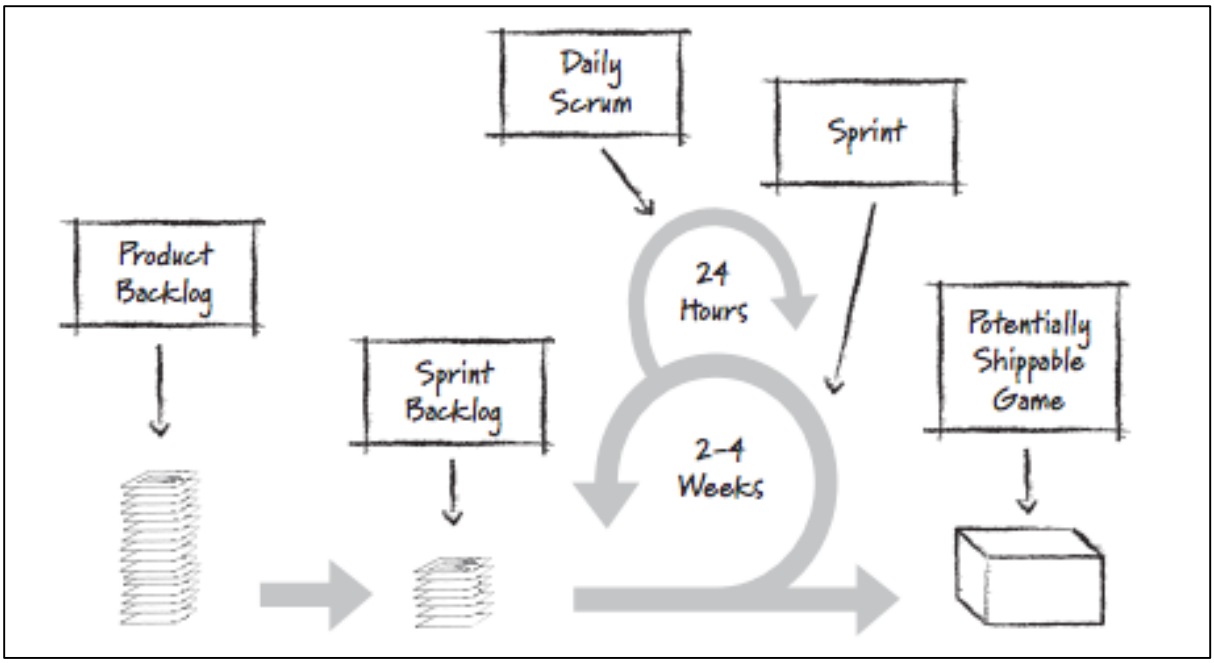


Figure 4-4: Process model of Scrum (Keith, 2010:39)

Scrum supports an agile philosophical approach. This philosophical approach focuses on practical application development and flexibility to satisfy business requirements. The method for this methodology consists of three levels of planning as previously mentioned. The process model is iterative and incremental. Product backlog and sprint backlog are two of the most common tools and techniques associated with this methodology. Scrum can therefore be regarded as an SDM as all the components that define an SDM are present.

4.3.1.3. MASAM (Jeong et al., 2008)

Mobile Application Software Based on Agile Methodology (MASAM) is an agile methodology that focuses on rapid application development. The key goal of this methodology is simple development and fast deployment of new mobile applications. This is achieved with the emphasis on copious involvement of the user in the development process. Furthermore, development teams consist of multiple individuals.

MASAM is divided into four phases: development preparation, embodiment, product development and commercialisation. In the first two phases prototyping, design, concept development and gathering requirements are involved. The product development phase is repeated to allow iterative development of the application. Subdivisions for this phase include requirements evaluation, testing and client compliance for each cycle.

1. Development preparation: The purpose of this phase is to determine what the client is going to use the application for. Activities associated with this phase are grasping product, product concept sharing and project setup.
2. Embodiment: In this phase the client's requirements are represented in concrete form. Activities associated with this phase are understanding user needs and architecting.
3. Product development phase: In this phase, the application is developed iteratively and released to the client after every cycle. Activities associated with this phase are environment setup, development and release planning, release cycle and release.
4. Commercialisation: In the final phase the focus is on getting the product ready for commercial use. Activities associated with this phase are system testing and product sales.

Simple development and fast deployment of mobile applications are the philosophical approaches of the MASAM methodology. The methodology takes an agile perspective for the development process. The method of this methodology consists of phases as previously mentioned. The process model focuses on sequentially completing one step after another until the development of the application is done. The release phase contains iterative steps that are repeated until the system is finished. Thus, the process model is sequential and iterative. Tools and techniques that are used by MASAM are product summary, story cards and pair programming. This is a complete methodology due to the fact that all the main components of an SDM are present.

4.3.1.4. Mobile-D (Abrahamsson et al., 2004)

Mobile-D is based on Extreme Programming, Crystal Methodologies and Rational Unified Process and is considered to be an agile development approach. This methodology focuses on developing a mobile application in the shortest possible time. To accomplish the shortest possible development time, the methodology requires a team of less than 10 people in a single room. The sole purpose of this team is rolling out a fully functional mobile application as fast as possible, usually within no more than ten weeks. The entire methodology consists of five iteration phases, namely set-up, core, core2, stabilise and wrap-up. Each of these phases is divided into different development days: Planning Day, Working Day and Release Day. An Integration Day is also needs when multiple teams are concurrently working on different parts of the application. In addition, each phase consists of the following nine elements: phasing and pacing, architecture line, mobile test-driven development, continuous

integration, pair programming, metrics, agile software process improvement, off-site customer and user-centred focus.

The philosophical approach focuses on agile development to produce mobile applications quickly. The method consists of five phases, divided into different days as previously mentioned. The process model is interactive with small releases. Tools and techniques associated with this methodology include phasing and pacing, architectural line and pair programming. The Mobile-D methodology is a full SDM as the methodology does consist of the main components of an SDM.

4.3.1.5. RAD with DSDM Atern (Beynon-Davies & Holmes, 2002; DSDM-Consortium, 2008)

Rapid Application Development (RAD) focuses on developing and delivering high quality systems in the shortest possible time and at the lowest cost. RAD was implemented as a new methodology, RAD Dynamic Systems Development Method (DSDM). DSDM is a framework that is based on the best practices and lessons learned and extended the original RAD methodology to RAD DSDM Atern. This methodology focuses on software to be developed in an agile environment. The researcher is aware that a newer version of the DSDM was published in 2014 (DSDM-Consortium, 2014). However, at the beginning of this study the newest version of the DSDM was the 2008 version and most of the work for this and following phases was based on the 2008 version. RAD DSDM Atern consists of seven key phases for software development.

1. Pre-project: The goal of this phase is to formalise a project proposal. This phase has four main activities: describe the business problem, identify a business sponsor and visionary and confirm that the project aligns with the business strategies.

2. Feasibility study: In this phase decisions are made regarding the viability of a proposed project from different perspectives. The main activities of this phase are to determine whether a feasible solution for the project exits, to determine what benefits will likely be presented by delivery, to identify every possible approach, to illustrate the project's organisational features, to provide preliminary projections of project timelines and cost as well as to plan and identify the resources required for the foundation phase.

3. Foundation phase: In the foundation phase modelling and prototyping are combined to assist in requirements gathering. The main activities of the phase

are to outline high-level project requirements, to identify which business processes are supported by the project solution, to indicate which data is used, to describe the deployment strategies, to develop a business case, to develop the initial design of the solution, to define technical implementation standards, to describe technical implementation standards, to describe quality assurance methods, to establish project governance and origination, to describe the development life cycle, to draw up an initial development and deployment schedule, to identify assets and to manage project risk.

4. Exploration: This phase entails translating business requirements into viable solutions in an iterative, incremental cycle. The main activities of this phase are to discuss the requirements gathered, describe the business needs in detail, develop a functional solution, provide the organisation with an early view of the solution, and elaborate on the products.

5. Engineering: The goal of this phase is to develop the fully operational system. The main activities for this phase are to refine the exploration phase solution to meet the solution requirements and to expand and refine any products required for live operation and support.

6. Deployment: In this phase the solution is implemented into live operation. The main activities for this phase are to confirm whether the performance and viability of the project are still in check, to deploy the solution into the market, to train end users if applicable, to provide supporting documentation, to train or provide documentation for support staff or operators and to assess the solution on the likelihood that it will meet the initial requirements.

7. Post-project: In this phase the project's performance is evaluated and the degree to which the solution does satisfy the business needs is determined. The only activity for this phase is to evaluate whether the intended business benefits have been achieved by the solution.

Figure 4-5 depicts the process and interaction of the seven phases, as described above, when following RAD with DSDM Atern.

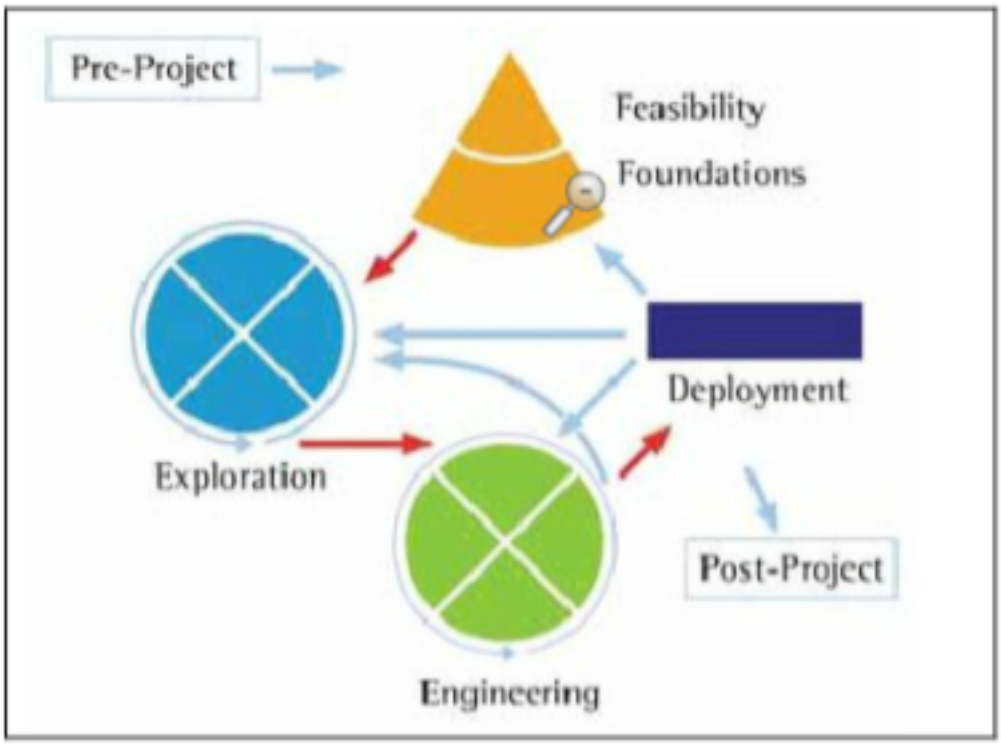


Figure 4-5: Process model of RAD with DSDM Atern (DSDM-Consortium, 2008)

The philosophical approach for the RAD DSDM Atern is based on the same approach as normal RAD, namely to develop an application as fast as possible at the lowest cost. The method proposed by this methodology consists of phases as previously mentioned. The model follows the phases sequentially with the deployment phase being executed iteratively. Business case and prototyping are tools and techniques associated with this methodology. This methodology is an SDM as all the components of an SDM are present.

4.3.1.6. MDA Framework (Hunicke et al., 2004)

Mechanics, Dynamics and Aesthetics framework (MDA) focuses on designing games by breaking the game down into its distinct components; that is rules that lead to the system and in turn lead to fun. After the components have been identified their counterparts for designing the game are identified, namely mechanics that lead to dynamics and in turn lead to aesthetics. The fundamental idea of MDA is that games are more like artefacts than media. The argument behind this is that thinking about games as designed artefacts helps frame them as a system that can be designed and developed by using a formal approach. MDA identifies each component as a lens or a view from which different spectators view the component. The designer of the game views the mechanics, dynamics and aesthetics, whereas the player views the rules, system and fun.

For MDA the components are executed on a reverse engineering basis as follows:

1. Aesthetics model: The aesthetics model describes the desirable emotional response of the player. In this model of the framework gameplay models are defined. These models aid in describing the dynamic and mechanic models that follow. This model also moves away from words, such as fun and gameplay and focuses on sensation, fantasy, narrative, challenges, fellowship, discovery, expression and submission.

2. Dynamic model: This describes the run-time behaviour of the mechanics acting on the player input. The dynamic model creates expressions from the aesthetics models. These expressions describe, for example systems for purchasing, building or earning game items, and designing, constructing and creating levels.

3. Mechanic model: The mechanic model describes the particular components of the game at data and algorithm level. This model describes and develops the various actions, behaviours and control mechanisms for the player within the gaming world.

4. Tuning: The last step of the methodology is tuning that refines the design goals and game flaws and measures the progress of the game design.

MDA supports iterative designing and tuning of game design. By iteratively moving between the three levels of MDA along with the tuning phase, this model conceptualises the dynamic behaviour of game systems.

Figure 4-6 depicts an example of how the MDA framework breaks down the components of the game into design components.

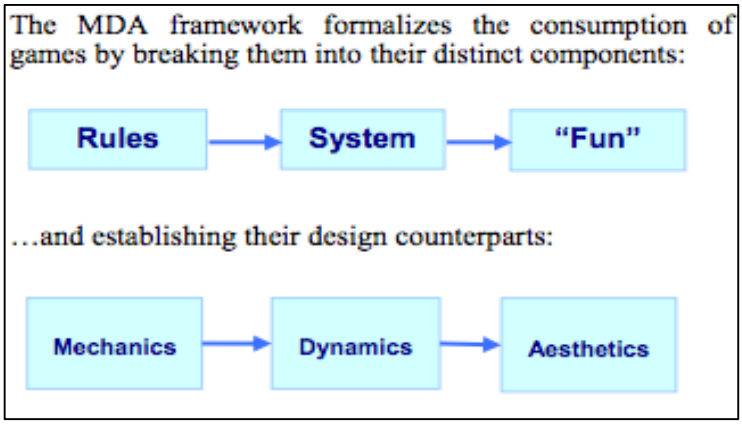


Figure 4-6: Example of MDA mapping game and design components (Hunicke *et al.*, 2004)

In addition, Figure 4-7 depicts the problem that designers and players have different perspectives when thinking of a game. The MDA framework tries to facilitate this by using the mapping of the game components and their design components.

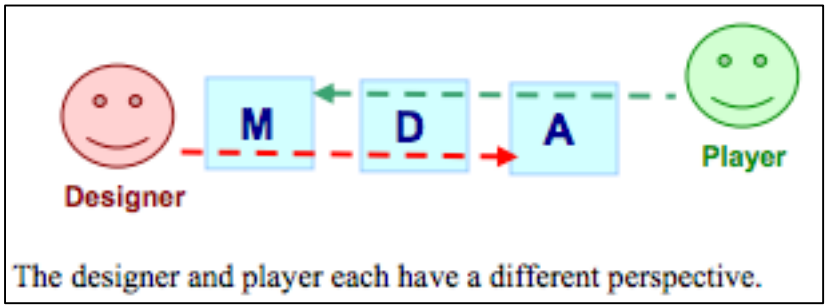


Figure 4-7: Different perspective of designers and players (Hunicke *et al.*, 2004)

The philosophical approach of MDA is to break a game down into its distinct components as previously mentioned. It focuses on defining a game as an artefact rather than media in order to minimise the complexity of the game. The method of MDA is defined as phase-based on the distinct components of a game. The model of this methodology indicates that the phases should be completed sequentially with different passes. Thus the model of MDA is iterative and sequential. Tools and techniques related to MDA are dynamic models, mechanic models and aesthetics models. MDA is a full SDM because all the components of an SDM are present.

4.3.1.7. Playability and Re-playability (Krall & Menzies, 2012)

A design methodology for games that is based on playability and re-playability is proposed in this section. This methodology, called Playability and Re-playability, is based on the design process of the two key factors that contribute to the success of a game, which are playability and re-playability. Playability and re-playability can be described in terms of six aspects,

namely social reasons, challenge, experience, mastery, impact, and completion. These six aspects of playability and re-playability are used to weigh game features and adjust the design phase of the methodology. The steps associated with the design phase are:

1. List the game's features: In this phase a very basic idea of the game is initiated. The outlines of the game are planned.

2. Estimate scores for the game's features: Estimate the features of the game by determining the importance of each of the six aspects for playability and re-playability.

3. Average the feature scores: Calculate the average score for each aspect and feature.

4. Determine the game's category: Estimate the category into which the game will fall.

5. Look up scores for category: By using learned results and previously analysed data sets, look up the player opinions regarding re-playability.

6. Adjust the game: Compare the estimate average score with the scores calculated in the previous step. This will be the fine-tuning phase of the game development process.

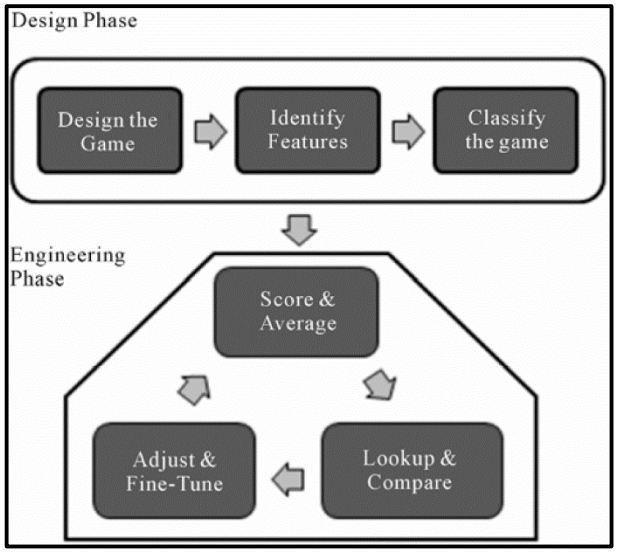


Figure 4-8: Playability and re-playability development process (Krall & Menzies, 2012)

The phases of this methodology can be seen in Figure 4-8. The tuning of the game can be done based on the features and attributes that will enhance the playability and the re-playability. The tuning of the game can be made based on the six aspects for playability and re-playability as previously mentioned. The tuning of the game is done by executing the following in the engineering phase:

1. Designing for social reasons: The game should cater for the player's socialising needs with other players. The features in this game should emphasise social play, teaming together and peer versus peer combat.

2. Designing for completion: The game should lure the player into completing the game or parts of the game. Typical features of such a game are compelling stories, logical flow of the game and attractive gameplay.

3. Designing for experience: It is not easy to provide tips or guidelines for designing experience. This is why, to design for experience, the game must be unique and memorable and have superb stories, rich virtual cultures and a vast world.

4. Designing for challenge: The concept of challenge provides the player with a sense that only the elite can accomplish and succeed in the game. There must be a balance between challenge and playability and re-playability. A game may never be too easy or too difficult.

5. Designing for mastery: The game must provide features that allow the player to feel that he/she has mastered a portion of the game. Examples of this are levelling up, upgrading equipment and training to become a master in the game.

6. Designing for impact: Designing for impact is designing randomness into the game. Once again there needs to be a balance between random and predestined paths for the player. If the game is too random, the player will feel that he/she has no control in the game.

This methodology bases its philosophical approach on playability and re-playability. It uses the six aspects of playability and re-playability to influence the design process to develop better game features and attributes to better satisfy the game's needs. The method of this methodology is based on two phases, each with its own steps that can be influenced by the six aspects of playability and re-playability. The model for this methodology is sequential with

the steps in the engineering phase being iterative. The entire development process can also be iterative based on the changes made from the six aspects of playability and re-playability. The tools and techniques associated with this methodology are the mathematical calculations based on the six aspects of playability and re-playability to calculate the features and attributes of the game. This is a complete SDM as all the components for an SDM are present.

4.3.1.8. Player-Centred game design (Sykes & Federoff, 2006)

The basis for this method is that games differ from business applications in that a business application is developed to satisfy the requirements for which the client asked, whereas games are not developed to satisfy the requirements of a client. This complicates the development process, because the game should satisfy different types of game requirement without having been specifically developed for a specific group of direct clients. This is why this method of game design focuses on the players of the game. The method identifies four distinct stages of game development, namely concept development, pre-production, production and post-production. Furthermore, the method integrates the player-centred design in these stages.

1. Concept development: Focuses on iterative designing of a game concept. A constraint that needs to be taken in to account is that there are different types of gamers, namely hard-core gamers, casual gamers, male gamers and female gamers. Each expects a different experience when playing a game.

2. Pre-production: Involves getting the team together to further design the game concepts and develop prototypes. The developers should also refine the player audience to determine the experience for each player type.

3. Production: In this stage the actual development of the game is done. As the development of the game progresses, the developers should keep the target players in mind.

4. Post-production: This stage refers to the stage after the game has been commercialised. This stage is the best time to gather player feedback on the game to use in the next project.

The philosophical approach of this method is to focus on the different players' experiences when developing the game. The method of Player-centred game design stipulates that there

are four stages. The model for this method is sequentially through the stages and iterative in each stage. There are no associated tools and techniques for Payer-centred game design, it allows the developers to identify and use their own tools and techniques. This means that Player-centred game design is a complete SDM as all the components for an SDM is present.

4.3.1.9. Summary of SDMs

The above-mentioned SDMs are summarised according to the definition of an SDM. The summary is presented in Table 4-1. This table indicates the four main components of each SDM and whether or not the SDM or method can be regarded as a complete SDM. Notwithstanding the fact that a method cannot be regarded as a full SDM, some of the processes of a method can still be used to contribute to the development of an SDM and will therefore be included in this evaluation.

In the next section the features of location-based games will be identified, from literature, and discussed. These features will then be used to formulate a definition for location-based games.

Table 4-1: Summary of SDMs

	Philosophical approach	Method	Process Model	Tools and Techniques	SDM classification
SDLC	Computer-based solutions to solve problems	Phases	Sequential	Milestones, checklists, CASE tools	Complete
Scrum	Agile development	Phases	Iterative and incremental	Product backlog and sprint backlog	Complete
MASAM	Simple fast development	Phases	Sequential	Product summary, story cards and pair programming	Complete
Mobile-D	Agile development	Phases	Iterative	Phasing and pacing, architectural line and pair programming	Complete

	Philosophical approach	Method	Process Model	Tools and Techniques	SDM classification
RAD with DSDM Atern	RAD	Phases	Sequential	Business case and prototyping	Complete
MDA Framework	Break down game into distinct parts	Phases	Iterative and sequential	Dynamic model, mechanic model and aesthetic models	Complete
Playability and Re-playability	Playability and re-playability	Phases and steps	Sequential and iterative	Calculations based on the six aspects of the playability and re-playability to calculate the features and attributes of the game	Complete
Player-centred game design	Different players' experiences	Stages	Sequential and iterative	Allow developers to identify own tools and techniques	Complete

4.3.2. Location-based game features

In recent years game development has started to focus on developing games for mobile platforms (Nicklas *et al.*, 2001; Avouris & Yiannoutsou, 2012). This shift of focus occurred because of the rapid development and advancement in mobile technologies (Nicklas *et al.*, 2001; Avouris & Yiannoutsou, 2012). This led to the creative development of new games that make use of location-monitoring technologies, better known as location-based services for mobile devices (Abrahamsson *et al.*, 2004). The term proposed to best describe these types of game is mobile location-based games or location-based games (Lonthoff & Ortner, 2007). To give a more comprehensive definition of location-based games, a set of features that can be included in location-based games will be discussed. Location and tracking are what uniquely identify and distinguish location-based games from other games and systems (Lonthoff & Ortner, 2007). These two features add to the complexity of developing location-based games.

4.3.2.1. Interaction

The first feature of location-based games is the interaction with the gaming world. Unlike the case of traditional games where the player sits in front of a screen and interacts with the game through a range of input devices, location-based games allow the players themselves to move around in the real world as if it were the gaming world (Nicklas *et al.*, 2001; Bell *et al.*, 2006). In other words, there are two mediums for interacting with location-based games. These are the players moving around in the real world and the mobile device that facilitates the simulation between the real world and the gaming world (Nicklas *et al.*, 2001; Bell *et al.*, 2006). Of these two interactions, the players moving in the real world interacting with different objects and other players are the primary form of interaction. The mobile device that is used to transport the player to the gaming world is the secondary method of interaction. This differs from traditional games where the mobile device is the primary method of interaction (Nicklas *et al.*, 2001). This important difference is what makes location-based games unique and completely different from traditional games.

4.3.2.2. Graphics, Sound and Augmented Reality (AR)

The game that is deployed on the mobile device can also have three features that will aid in the interaction with the game and these features are graphics, sound and augmented reality (AR). The player as integrator is not enough to create a believable gaming world. In conjunction with the player, a system is needed that can interpret the information that is supplied by the player to fully immerse the player in the simulated world (Herbst *et al.*, 2008; Wetzel *et al.*, 2008). This is done by using graphics and sound. Graphics and sound features in most modern-day games. These two features will enhance the experience of playing the game and the reality of the gaming world. The last feature is AR, which allows the game to interact with the real world besides the location of the player (Herbst *et al.*, 2008; Wetzel *et al.*, 2008). This interaction can include reading certain markers or barcodes to input data for the game that can be used in a specified manner by the game (Herbst *et al.*, 2008; Wetzel *et al.*, 2008). AR can also allow the game to interact with the real word by projecting information of the game from the real world (Herbst *et al.*, 2008; Wetzel *et al.*, 2008). Using the camera of the mobile device usually does this. The image that the camera captures will then be augmented and be displayed differently on the hand-held device. Usually this will form part of the gaming world. Lastly, AR can also allow players to interact in close proximity to each other (Herbst *et al.*, 2008; Wetzel *et al.*, 2008).

4.3.2.3. Artificial Intelligence (AI)

Depending on the type of location-based game, artificial intelligence (AI) can be applied to enhance the game. AI is one of the features that most games incorporate to give life to the game by simulating intelligence in the gaming world for characters, background entities or interaction with certain intelligent agents (Millington & Funge, 2009:7-12).

4.3.2.4. Mobility

Another feature of location-based games is mobility. As previously mentioned, the primary interaction for location-based games is between the players and the movements in the real world (Nicklas *et al.*, 2001; e Silva, 2009). This implies that the players need to be mobile, i.e. the players need to be able to move in the real world (Nicklas *et al.*, 2001; e Silva, 2009). For this reason, the game needs to be available on a mobile platform to allow the user to move in the real word and to translate these movements as input into the gaming world (Nicklas *et al.*, 2001; e Silva, 2009). This is why location-based games are mobile games that are usually deployed on Smartphones, Tablets and some Notebooks (Nicklas *et al.*, 2001; e Silva, 2009).

4.3.2.5. Location

The most important feature of location-based games is the ability to determine the location or position of the player (Lonthoff & Ortner, 2007). Determining the location of the player is the central, most important feature of location-based games as the rest of the game revolves around the position of the player (Lonthoff & Ortner, 2007). When the position of the player is determined, it is used as input for the game and the gaming world is created around the player's position (Rashid *et al.*, 2006; Lonthoff & Ortner, 2007). This is one of the reasons why it is important that location-based games are mobile. The position or location of a player is usually determined by using the available hardware on the mobile device (Rashid *et al.*, 2006; Lonthoff & Ortner, 2007). This can include using Global System for Mobile Communication (GSM) or Global Positioning System (GPS) to determine the location of the player (Rashid *et al.*, 2006; Lonthoff & Ortner, 2007).

4.3.2.6. Tracking

After determining the location or position of the player, tracking the movement and whereabouts of the player is required. This is one of the key features that is needed in playing location-based games. The game will determine the current location of the player at predefined time intervals (Herbst *et al.*, 2008). This allows the game to track the movement of the player and then to simulate the movement in the gaming world, thereby allowing the player to semi-immerse himself/herself in the gaming world by completing tasks in the real

world (Herbst *et al.*, 2008). To accomplish this integration, the game will then use GSM and GPS to continuously determine the location of the player in order to track his/her movements and whereabouts (Avouris & Yiannoutsou, 2012).

4.3.2.7. Communication

The next feature of a location-based game is the communication with different sources. There are two different setups for location-based games, namely on-line and off-line. In the off-line setup, the only communication with the game is in order to determine the location of the player. This communication will be via GSM or GPRS (Rashid *et al.*, 2006; Lonthoff & Ortner, 2007; Herbst *et al.*, 2008; Avouris & Yiannoutsou, 2012). An on-line location-based game incorporates the off-line communication with an additional communication process (Lonthoff & Ortner, 2007; Herbst *et al.*, 2008). In this process, communication is required with the game server (Lonthoff & Ortner, 2007; Herbst *et al.*, 2008). The communication between the client and the server can be facilitated by GSM or Wi-Fi (Wireless network) networks (Lonthoff & Ortner, 2007; Herbst *et al.*, 2008). The game server uses the data that is received to determine numerous tasks. The reason for the different setups is that the on-line setup allows the player to interact with other players who are playing the same game. The on-line version also allows the gaming world to change the base activities on the gaming server interactively (Lonthoff & Ortner, 2007; Herbst *et al.*, 2008). The off-line game allows the player to play exclusively on the mobile device where the game is deployed, with all the benefits except those which a game server can provide as mentioned. It is important to note that a location-based game can never be completely off-line, as the communication to determine the location of the player is always needed (Rashid *et al.*, 2006; Lonthoff & Ortner, 2007; Herbst *et al.*, 2008; Avouris & Yiannoutsou, 2012).

4.3.2.8. Game Server

The last feature that a location-based game requires is a gaming server if the game is on-line. The server will govern the gameplay as it progresses for each player and will also allow players to interact with each other. As stated previously, the communication with this server will be either GSM or Wi-Fi (Cheok *et al.*, 2004; Lonthoff & Ortner, 2007; Herbst *et al.*, 2008). Another type of server that location-based games can use is a server that provides location-based services, such as weather services, direction APIs and Google Maps (Kasapakis *et al.*, 2013). These location-based services can also be used to govern the game as it progresses (Kasapakis *et al.*, 2013).

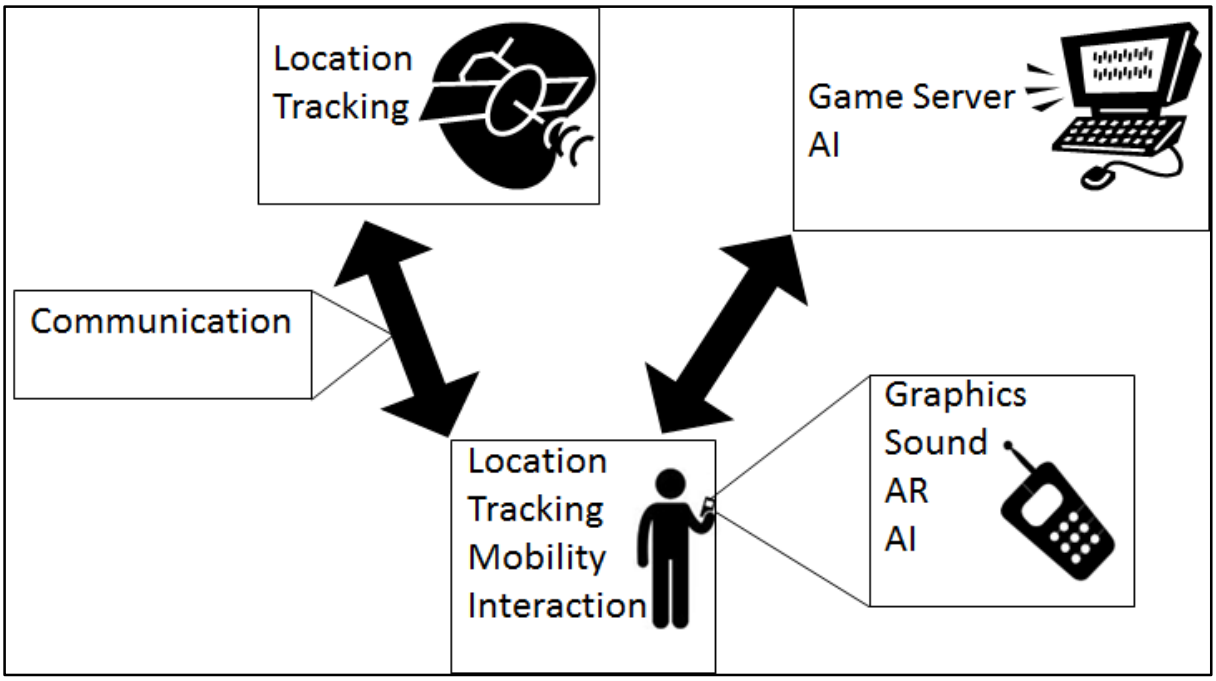


Figure 4-9: Features for location-based games

Each of these features can be dependent on the other and cannot function without some of the other features. In Figure 4-9, the interaction of these features can be seen.

Based on the above information the following definition can describe a location-based game:

"A location-based game is a type of ubiquitous mobile game that incorporates the location and tracking of the player as part of the gaming world. Furthermore, a location-based game can incorporate graphics, sound, augmented reality and artificial intelligence to further immerse the player in the gaming world. A location-based game can also make use of game servers to allow for multiplayer and online modes."

In the next section of this phase the aspects that are needed in the development process for location-based games will be identified and described.

4.3.3. Aspects needed to be addressed in the development process of location-based game development

To determine the suitability of an SDM to aid in the development of location-based games, it has to be determined to what degree SDMs can address certain aspects that need to be addressed in the process of developing location-based games. These aspects will be identified based on information gathered from the literature. The literature review will focus on aspects needed for a successful mobile application development process, game development process, as well as a mobile game development process. This is done to

ensure that these aspects will better represent the needs of developing a location-based game. These aspects will be evaluated by using a survey to measure their importance in the development process and also to determine if any aspects were overlooked. Finally, the aspects will be used to develop the framework to evaluate the suitability of an SDM for location-based games development.

4.3.3.1. Playability

Playability can be defined as the property of an activity that has the ability to yield enjoyment (Krall & Menzies, 2012). This binary measure indicates whether or not a game can be enjoyed (Krall & Menzies, 2012). This is one of the factors that determines the success of a game release (Krall & Menzies, 2012). This is very important, as the main objective of any game is to provide the player with an enjoyable experience when playing the game. Playability leads to player experience, which is another aspect that will be discussed later (Nacke *et al.*, 2009). Based on this it can be said that playability is a prerequisite for player experience (Nacke *et al.*, 2009). Playability is regarded to be very important to the game development process. The importance of playability can be further emphasised by indicating that there is a dedicated research area that focuses on playability heuristics (Desurvire *et al.*, 2004; Korhonen & Koivisto, 2006; Korhonen & Koivisto, 2007; Nacke *et al.*, 2009). This research focuses on determining issues with playability, as well as how to improve the playability of games (Korhonen & Koivisto, 2006; Korhonen & Koivisto, 2007). The research also mentions that usability alone is not enough in game development and that playability is also needed (Korhonen & Koivisto, 2006).

4.3.3.2. Player experience

As mentioned, playability is a prerequisite for player experience that emphasises the tightly connected nature of these aspects. The difference between the two factors is that playability is the evaluative process of the player in respect of the game, whereas player experience is the evaluation of the players (Nacke *et al.*, 2009). Player experience describes all sensorial experiences that a player experiences when playing a game (González-Sánchez *et al.*, 2012). Player experience can be compared with user experience in traditional information systems. The difference is that games are interactive systems with the main objective of exploiting the feelings of the player and ensuring fun and entertainment (Hagen, 2011; González-Sánchez *et al.*, 2012). This difference enhances the complexity of player experience in a game compared to that of information systems (Nacke & Drachen, 2011; González-Sánchez *et al.*, 2012). However, it is insufficient to analyse the player experience by only using usability (Korhonen & Koivisto, 2007; Nacke & Drachen, 2011). Usability, as well as playability are needed for the player experience to be fully incorporated in the game

development. In the game design process player experience is an important focus and needs to be incorporated in the development of games (Nacke & Drachen, 2011).

4.3.3.3. Usability

Usability can be defined as the effectiveness, efficiency and user satisfaction in a specific context of use (Stewart, 1998). Player experience benefits from incorporating usability in the game design process (Nacke & Drachen, 2011). Furthermore, usability also affects playability (Nacke *et al.*, 2009). By considering these two facts, it is clear that usability is important for game development. Another measure of the importance of usability is that the gaming industry is adopting formal techniques from human computer interaction (Nacke *et al.*, 2010). These techniques are known as usability heuristics. Different usability heuristics to evaluate the usability of the game exist (Korhonen & Koivisto, 2006; Nacke *et al.*, 2009; Nacke *et al.*, 2010; Hagen, 2011). As mentioned, by only applying usability to analyse the player experience is not sufficient due to the fact that games are more complex (Korhonen & Koivisto, 2006; Korhonen & Koivisto, 2007) and applying these usability heuristics improves the design of games (Nacke *et al.*, 2010).

4.3.3.4. Value to the player

Value to the player is also known as value to the user in the case of mobile applications. In this phase, the term value to the player will be used. There are many mobile games that compete to be downloaded and played by players. An application or game is worthless if it does not add value to the player (Verkasalo, 2008). In other words, what makes a person choose a mobile game or application is the value that the game or application has for the person. This is done by utilising the functionality of the platform on which the mobile game or application is deployed, in this case a mobile device (Rice & Katz, 2008; Feijoo *et al.*, 2012). This functionality is valuable to the player if there is no other mobile game or application that can utilise the mobile device as the specific mobile game or application, thereby ensuring a unique gaming experience (Rice & Katz, 2008; Feijoo *et al.*, 2012). Mobile applications or mobile games must also share their time with other activities conducted on the player's device, such as listening to music and instant messaging (Feijoo *et al.*, 2012). Another aspect that contributes to the value of the mobile game or application is incorporating the game or application into everyday life. Mobile games or applications that can increase the productivity, help players perform day-to-day tasks, save time and relax players are a few factors that can increase the value for the player (Verkasalo *et al.*, 2010; Kao *et al.*, 2012). Based on this, it is clear that value to the player is important and should be taken into account when developing a game.

4.3.3.5. User interface design

Location-based games are usually deployed on mobile devices as a location-based game is a mobile application. Knowledge about mobile applications with regard to the user interface design is therefore also relevant for location-based games. The fact that location-based games are developed for hand-held devices allows the interface to be divided into three user interfaces (UIs), namely graphical user interface (GUI) (Heo *et al.*, 2009; Plaza *et al.*, 2011), logical user interface (LUI) (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010) and physical user interface (PUI) (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). The GUI includes components that render the gaming world on the screen of the device (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). The LUI represents the logical flow of the mobile game (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). This can be navigation, player controls, menus and the use of gesture in the gaming world (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). PUI is the physical medium that the player uses as input for the mobile game (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). This can be keyboard, touchscreen and different sensors, such as GPS, camera, accelerometer, etc. (Heo *et al.*, 2009; Unhelkar & Murugesan, 2010). During the development of a location-based game, these UI designs will be incorporated to improve the satisfaction of playing the game.

4.3.3.6. Development team

The development team in a game company consists of different specialists (Cohendet & Simon, 2007; Bach *et al.*, 2010; Novak, 2011:319-360). This adds complexity in managing the development process of games (Cohendet & Simon, 2007; Bach *et al.*, 2010; Novak, 2011:319-360). Management needs to be able to create a balance between the needs of the different specialists, as well as the managerial tasks of the development team (Cohendet & Simon, 2007; Bach *et al.*, 2010; Novak, 2011:319-360). The development process needs to take into account that different specialists need to work together on the same project. If the development process can address this aspect, it can reduce the complexity of management previously mentioned.

4.3.3.7. Re-playability

Re-playability can be defined as the quantifiable measure for the enjoyment that a player experiences while playing the game (Frattesi *et al.*, 2011; Krall & Menzies, 2012). Re-playability also refers to the number of times a person can enjoy playing the specific game (Krall & Menzies, 2012). Re-playability can also be divided into different aspects, namely difficulty, completion, social aspects, randomisation and the experience (Hansen *et al.*, 2013). The re-playability of games keeps players interested in the game until the next

instalment of the game is released or a game that is similar is released (Frattesi *et al.*, 2011). Without re-playability a game would soon be discarded (Frattesi *et al.*, 2011). It is therefore very important for a game to be re-playable and that designers design games to be re-playable when applicable (Frattesi *et al.*, 2011). Due to the fact that most location-based games are restricted to a specific area in which they can be played, players can quickly become bored with the same game (Hansen *et al.*, 2013). This is why it is important that the development process takes re-playability into account to allow players to replay the game as many times as possible without getting bored (Frattesi *et al.*, 2011; Hansen *et al.*, 2013).

4.3.3.8. Learnability

Learnability can be defined as a player's capacity to understand and master the game (Ryan & Siegel, 2009; Padilla-Zea *et al.*, 2013). This can include the game's mechanics, objectives, rules and how to interact with the game (Ryan & Siegel, 2009; Padilla-Zea *et al.*, 2013) Learnability should also offer the player satisfaction in learning the game (Ryan & Siegel, 2009; Padilla-Zea *et al.*, 2013). It should also expand the player's knowledge and techniques to resolve new games' challenges (Ryan & Siegel, 2009; Padilla-Zea *et al.*, 2013). Learnability is one of the aspects that also influences the playability, as well as usability of a game (Ryan & Siegel, 2009; Padilla-Zea *et al.*, 2013). To focus on learnability as one of the aspects in the development process of games could enhance the playability and the usability of the game.

4.3.3.9. Efficiency

Efficiency is one of the measures that directly impacts usability (Stewart, 1998). By this it can be said that usability incorporates efficiency (Federoff, 2002). Efficiency can be described as the player using the least amount of resources to achieve the goal of the game also known as efficiency in user interaction (Federoff, 2002). Furthermore, the efficiency of utilising hardware is also a crucial factor for mobile games, as resources on hand-held devices are limited (Lukashev *et al.*, 2006). For example, mobile games need graphics, sound and location-based services. For all these services the efficiency needs to be taken into account in the development of the game (Lukashev *et al.*, 2006).

4.3.3.10. Security and privacy

Security and privacy, although two very different concepts, are usually utilised in combination, as they are interdependent. Location-based games or services need to ensure that the location privacy of the players is secure (Scipioni & Langheinrich, 2010). If this is not done, the location or location history of the player can be made known to certain people

(Scipioni & Langheinrich, 2010; Puttaswamy *et al.*, 2014). When the players start to share, it does not mean that the players want to share all the information with everybody (Scipioni & Langheinrich, 2010). This is why it is important when developing a location-based game that privacy is kept in mind. The challenge of location-based games is in securing the privacy of the player without sacrificing the accuracy of the game (Puttaswamy *et al.*, 2014). This is why it is important that security aspects need to be included in the development process of a location-based game. Another reason why security and privacy should be one of the main aspects in the development process of a location-based game was discussed in the previous chapter. The security awareness survey in this chapter clearly showed that the computer science students did not take the necessary precautions to protect themselves when using location-based technologies, services and games. For this reason, it is the responsibility of the developer of location-based games to ensure the safety of the players. One of the ways of doing this is to ensure that the SDM that the developers follow incorporates security as one of the key development processes.

4.3.3.11. Availability and accessibility

Mobile games, such as location-based games do not serve a purpose if they cannot be distributed to and utilised by players. Due to the rapid development and the shift mobile technology made to Android, Apple and Blackberry, the distribution and utilisation of mobile games have been simplified (Holzer & Ondrus, 2011). By creating centralised application or game portals, updates can be readily available, helping to reduce the management and support of these applications and games (Kim *et al.*, 2009; Verkasalo *et al.*, 2010; Al Bar *et al.*, 2011). The effect that availability and accessibility have on developers, are that they need to incorporate and work towards publishing games and applications onto various markets to make it accessible to the public. These application markets make it possible for developers, with a level of ease, to make sure that applications and games are more available to the public (Kao *et al.*, 2012). For these reasons it is important to ensure that the development process of a location-based game incorporates availability and accessibility.

4.3.3.12. Cognitive support

This aspect focuses on structuring the game's controls or input logically so that the player can play the game without uncertainty or excess effort (Heo *et al.*, 2009). It is important that players can be able to predict the flow of operations when planning to perform a task on the game or application (Kao *et al.*, 2012). If the cognitive flow of an application or game is designed effectively, the user or player's chance of making a mistake decrease (Benbunan-Fich & Benbunan, 2007; Heo *et al.*, 2009). In addition, the cognitive process is the process a player carries out when executing a mobile phone task namely: planning, execution,

translation and assessment (Heo *et al.*, 2009). A mobile game should also support these steps to decrease the effort of playing the game.

4.3.3.13. Compatibility

The rapid development of the mobile market has increased the different mobile devices and platforms (Viana & Andrade, 2008; Duarte & Afonso, 2011). This can result in complications for the development of location-based games, such as screen size, input device, control structures for sensor, etc. (Viana & Andrade, 2008; Duarte & Afonso, 2011). Because of these constraints, the development of any mobile application or game can be time consuming if a new project has to be developed for all platforms (Viana & Andrade, 2008; Duarte & Afonso, 2011). Therefore, it is important that different techniques should be utilised for cross-platform development (Viana & Andrade, 2008; Ali *et al.*, 2010). The techniques that could aid in the development for different platforms are: using web application and the use of application programming interfaces (APIs) that allow cross-platform development (Duarte & Afonso, 2011).

4.3.3.14. Adaptability

Adaptability can be described in two dimensions. The first is that the game should be adaptable to the context within which it is being used (Ali *et al.*, 2010; Verkasalo *et al.*, 2010; Kao *et al.*, 2012). This can include making use of data, such as time, day, weather, GPS location and Internet connectivity (Ali *et al.*, 2010; Verkasalo *et al.*, 2010). Secondly, the game should be able to adapt to the players' specifications, such as configuration display options, sounds, different sensor settings, difficulty settings, vibrations, etc. (Ali *et al.*, 2010; Verkasalo *et al.*, 2010; Kao *et al.*, 2012). Lastly, location-based games usually focus on only one location for the game to be played (Hansen *et al.*, 2013). If adaptability is incorporated in the development process, it may allow the location of the location-based game to be adaptable to the player's surroundings, adding another dimension to the location-based game (Hansen *et al.*, 2013).

4.3.3.15. Organisational structure

The organisational structure of a gaming company does not reflect the traditional structure of functional departments (Cohendet & Simon, 2007; Tschang, 2007). Gaming companies resemble project-based firms (Cohendet & Simon, 2007; Tschang, 2007). Furthermore, if a gaming company is to be classified as a project-based firm, the nature of the company exhibits specific aspects that are different from more traditional project-based firms (Cohendet & Simon, 2007; Tschang, 2007). The complexity of managing a game project lies

in the ability to maintain a balance between different specialists (Cohendet & Simon, 2007; Tschang, 2007). Another complexity that is added to the development of game projects is that there needs to be a balance between artistic flexibility and strict managerial devices (Tschang, 2007). The development process needs to take this into account when a game is being developed.

In summary, 15 aspects, which are needed in the development process of location-based games, were identified from literature that focuses on the development process of mobile applications, games and mobile games. Each aspect was described in detail.

In the next section an online-questionnaire will be used to determine each aspect's importance in regards to the development process of location-based games. Games developers will be contacted and asked to complete the questionnaire. This will then be used to develop the framework that can be used to evaluate the suitability of SDMs to aid in the development of location-based games. Finally, the development of the framework will be discussed.

4.4. The development of the framework

4.4.1. The questionnaire for ranking the importance of the aspects needed in the location-based development process

The ranking of the importance of aspects needed in the location-based development process questionnaire contained 15 questions, each representing one of the aspects identified previously. The respondents were asked to indicate on a scale of one to ten the importance of the specific aspect with regard to the development of a location-based game. Table 4-2 indicates how the questionnaire to rank the importance each aspect has in the development of a location-based game was developed. This table shows the research objectives, information required, research variables, the type of question and format and the reference. Furthermore, this table also contains the references that were used to identify each research variable.

Table 4-2: The development of the questionnaire for ranking aspects

Research Objective	Research variables	Question type and format	Reference
Rank the importance of the identified aspects with regard to developing a location-based game.	Playability Player Experience Usability Value to the Player User Interface Design Development Team Re-playability Learnability Efficiency Security and Privacy Availability and Accessibility Cognitive Support Compatibility Adaptability Organisational Structure	Question Type: List Question Format: Likert scale from 1 to 10, where 1 means least important and 10 means most important	(Stewart, 1998; Federoff, 2002; Desurvire *et al.*, 2004; Korhonen & Koivisto, 2006; Lukashev *et al.*, 2006; Cohendet & Simon, 2007; Korhonen & Koivisto, 2007; Tschang, 2007; Rice & Katz, 2008; Verkasalo, 2008; Viana & Andrade, 2008; Heo *et al.*, 2009; Kim *et al.*, 2009; Nacke *et al.*, 2009; Ryan & Siegel, 2009; Ali *et al.*, 2010; Bach *et al.*, 2010; Nacke *et al.*, 2010; Scipioni & Langheinrich, 2010; Unhelkar & Murugesan, 2010; Verkasalo *et al.*, 2010; Al Bar *et al.*, 2011; Duarte & Afonso, 2011; Frattesi *et al.*, 2011; Hagen, 2011; Holzer

Research Objective	Research variables	Question type and format	Reference
			& Ondrus, 2011; Nacke & Drachen, 2011; Novak, 2011; Plaza *et al.*, 2011; Feijoo *et al.*, 2012; González-Sánchez *et al.*, 2012; Kao *et al.*, 2012; Krall & Menzies, 2012; Hansen *et al.*, 2013; Padilla-Zea *et al.*, 2013; Puttaswamy *et al.*, 2014)

4.4.2. Evaluation and verification of the aspects

The detailed description of the survey, and the design science research method was provided in Chapter 2. The results of the questionnaire will be used to determine the importance of addressing each of the aspects for the development of location-based games. In addition, the survey also had open-ended questions that allowed the respondents to add additional aspects if any were overlooked. Descriptive statistics were performed on the data. The average score for each aspect will then be used as a weight to help score each SDM's suitability with regard to location-based development.

The results of the 78 completed questionnaires are shown in Table 4-3. Frequency analysis was also carried out on the data to show the frequency distribution of each question and the number of times each ranking occurs. This is illustrated in Table 4-4.

In Table 4-3 the aspects have been arranged according to the average each aspect scored in the survey. It is not surprising that playability ranked the highest amongst all the aspects according to mobile games developers and location-based games developers, as this is one of the most important aspects in games (Nacke *et al.*, 2009). It is also interesting to see that the three aspects that are closely related, namely playability, user experience and usability

scored the highest out of all the aspects. The results confirmed the findings in the literature that playability was more important than player experience, as playability is a prerequisite for player experience (Nacke *et al.*, 2009).

The security and privacy aspect scored an average of 7.11 which is lower than the average of 7.33 for all the aspects. From this it would seem that although security and privacy is important to the developers it is not as important as one would expect in the light of the results of the first phase. To ensure the development of secure location-based games, there should be more emphasis on security and privacy in the development process.

The aspect that scored the lowest was organisational structure. This might be due to the fact that games developers still try to be solo developers or lone wolf developers, as was the case at the inception of game development (Keith, 2010:6-9). The average score of 73.3% (7.33 out of 10) for all the aspects indicates that the games developers on average agreed that the aspects identified were important for the development of location-based games.

In addition to the average, the median, minimum, maximum and standard deviation were calculated to demonstrate the grouping of the data. Most of the aspects' standard deviations were between 1.77 and 2.73 with a total standard deviation for the entire dataset of 2.44. The ranking of the aspects seems to indicate that the games developers agree with the identified aspects. Although the games developers agree with the identified aspects, it is important to analyse the open-ended question in order to add overlooked aspects that the games developers identified. Table 4-5 summarises the responses to the open-ended question.

Table 4-3: Results of ranking aspects

	Average	Median	Minimum	Maximum	Standard Deviation
Playability	8.81	10	3	10	1.77
Player Experience	8.70	10	1	10	1.91
Usability	7.93	8	3	10	1.90
Value to the Player	7.67	8	1	10	2.44
User Interface Design	7.47	8	2	10	2.12
Development Team	7.37	8	1	10	2.32
Re-playability	7.34	8	1	10	2.47
Learnability	7.15	7	1	10	2.31
Efficiency	7.14	8	1	10	2.46

	Average	Median	Minimum	Maximum	Standard Deviation
Security and Privacy	7.11	8	1	10	2.69
Availability and Accessibility	7.07	7	1	10	2.56
Cognitive Support	6.90	7	1	10	2.20
Compatibility	6.62	7	1	10	2.73
Adaptability	6.40	7	1	10	2.53
Organisational Structure	6.23	6	1	10	2.57
Average *(Total value for entire dataset)	7.33*	8.00	1.33	10.00	2.44*

Table 4-4 is added as part of the descriptive statistics to indicate the distribution of the rankings across the different aspects. The frequency indicates the number of times that a rank was given by the participants for that aspect. Ranking 10 with a frequency of 42 for playability shows that 42 of the 78 participants ranked playability's importance 10 out of 10.

Table 4-4: Frequency analysis

	Ranking									
	1	2	3	4	5	6	7	8	9	10
Playability	0	0	1	4	3	0	2	9	17	42
Player Experience	1	0	0	3	4	2	3	10	12	43
Usability	0	0	3	3	2	6	10	21	10	23
Value to the Player	1	3	3	3	5	6	5	17	9	26
User Interface Design	0	2	2	4	6	7	16	13	10	18
Development Team	2	1	2	4	6	7	14	13	8	21
Re-Playability	2	2	4	3	6	10	6	12	15	18
Learnability	1	3	2	3	8	9	14	12	8	18

	Ranking									
	1	2	3	4	5	6	7	8	9	10
Efficiency	1	2	6	4	6	11	6	14	10	18
Security and Privacy	3	2	3	7	7	5	8	9	11	23
Availability and Accessibility	1	4	3	4	9	11	12	4	7	23
Cognitive Support	1	1	3	7	8	9	15	15	5	14
Compatibility	3	5	4	5	14	4	8	12	7	16
Adaptability	3	2	6	7	11	7	16	8	4	14
Organisational Structure	5	2	4	5	15	10	12	7	6	12

The aspects that have been identified will be matched to the answers of the open-ended question and the additional aspects will be added if there are any. The open-ended question that do not have a match will be evaluated to determine whether or not it is a new aspect that was not included in the original list. As can be seen in Table 4-5 in the analysis of the response column, there were no suggestions that the games developers made that were either already considered or not an aspect of location-based games, but rather part of the development process of location-based games.

Table 4-5: Response of open-ended question

Response to open-ended question	Analysis of response
Accuracy	Can be matched to Efficiency.
Mood. Although this aspect has quite a bit to do with player experience, I would say it deserves its own ranking. Location-based games have a thrilling aspect to them, due to the relevance of actual physical distance and how it maps to the gameplay, and a dark, sombre atmosphere would definitely enhance a suspenseful location-based game, for instance music and sound effects, whenever applicable, also play a good role in setting the right mood.	Can be matched to Player experience, Playability.
You seem to have identified most of the elements of good game design. Ranking them is difficult as a successful game needs to balance *all* of these.	Comment about current aspects.

Response to open-ended question	Analysis of response
Prototyping	Will not be added as an aspect of location-based games development. Prototyping is a tool or technique used in the development process.
Play testing	Will not be added as an aspect of location-based games development. Play testing is a tool or technique used in the development process.
Unique Location Design	Incorporated during definition of location-based game. All the current aspects are aimed to achieve this goal.
Real-World Integration	Can be matched to Player experience, Playability, Re-playability.
The game should happen in the real world, the technology (smartphone pp) should be an important part but not self-sufficient (you have to go to place X to play smartphone game Y)	Comment. Incorporated during definition of location-based game.
Game design	Game design is a phase in the development of location-based games.
Graphics	Can be matched to User interface design.
Documentation	Will not be added as an aspect of location-based games development. Documentation is a tool or technique used in the development process.
Challenge	Can be matched to Playability, Re-playability, Player experience.
Rules	Can be matched to Playability, Re-playability, Player experience.
Customisation	Can be matched to Adaptability.
Player feedback	Can be matched to Value to the player, Usability.

Response to open-ended question	Analysis of response
Audio	Can be matched to Player experience, Playability, Re-playability, Efficiency.

4.4.3. Evaluation of SDMs

Each of the SDMs chosen for this phase of the study will be analysed and measured against the identified aspects. Each SDM will receive a percentage score, which will be based on the extent to which the SDM supports the aspects. The results of the evaluation are presented in the discussion of results (**Appendix 4**). It should be noted that the evaluations of the SDMs were done by the researcher, as well as three independent mobile games developers.

The developers were given a blank copy of **Appendix 4** and were asked to score, as a percentage, the suitability of each SDM for supporting the aspects in the development process.

4.4.4. Inter-coder reliability

As mentioned, three independent mobile games developers were asked to use the framework to evaluate the list of SDMs along with the researcher's evaluation. To determine to what extent all the developers and researcher scored the aspects for each SDM the same, Krippendorff's alpha was used. An α value larger than 0.8 is the norm for a very good reliability, followed by an α smaller than 0.8 and larger than 0.67 as a good reliability and α's smaller than 0.67 being rejected (Hayes & Krippendorff, 2007). To calculate the Krippendorff's alphas in this phase, the measurement level of testing the variables was set to an ordinal scale as the developers and researcher scored the percentage by which each SDM addresses the specific aspect. The results for Krippendorff's alphas are represented in Table 4-8. Each of the Krippendorff's alphas in the table represents the reliability of the developers and researcher scores with regard to all of the aspects for the specific SDM. The Krippendorff's alpha for the SDLC was 0.726 that indicated a good reliability between the score each developer and researcher gave for each aspect. The SDM where the reliability was the highest is for RAD with DSDM Atern with 0.828 and the lowest scoring SDM was Mobile-D with 0.706. It can be seen that all the scores for the SDMs reflect a good reliability except for RAD with DSDM Atern that has a very good reliability. The average Krippendorff's alpha for all SDMs was 0.734. This proves good inter-coder reliability for the scoring of the aspects and SDMs and that none of the scores needs to be excluded.

Table 4-6: Krippendorff's alpha

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Frame-work	Play-ability and Re-playabili ty	Player-centred game design	Average Krippen dorff's alpha
Krippen dorff's alpha	0.726	0.743	0.709	0.706	0.828	0.763	0.738	0.733	0.734

4.4.5. Results of evaluating the SDMs

The results of the evaluation of the SDMs across the aspects are summarised in **Appendix 4**. The w or weight for each aspect is the average the aspect received in the survey. The results for each developer (will be referred to as coder) and the researcher are given in the first cell of the results. The C1 to C3 indicate the percentage each coder gave for the SDM considering the specific aspect in the development process. In the same cell the same results for the researcher are also reported and indicated as A1. In the second cell of the results the average of all the coders and the researcher is reported, as well as the final score for the SDM aspect. The average is indicated as AVG followed by "=>", the final score for the SDM and aspect. The calculations for the framework are discussed below. As **Appendix 4** is very large a smaller subset of the table will be used to explain the results.

By using the weight (w) assigned to the aspect and the average percentage for the SDM, the framework can be used to score the suitability of each SDM for each aspect. To calculate the framework's suitability score, the weight (w) for each aspect was multiplied with the average percentage each SDM received for that aspect, for example: to calculate the suitability the SDLC has with regard to Playability the weight (w) of 8.81 was multiplied with the average percentage of 8.75 to calculate the SDM suitability score of 77.09 as shown in Table 4-6. The maximum that any aspect can receive is calculated by multiplying the weight (w) of the aspect with 100 that represents the maximum percentage score an aspect can receive. The results for each SDM and aspect pairs can be seen in **Appendix 4**.

Appendix 4 also indicates the suitability an SDM has for all the aspects, as well as the suitability all the SDMs have for a single aspect. A smaller subset of the results is given in Table 4-6. The percentage by which an SDM is suitable for aiding in the development of a location-based game was determined by adding the scores each aspect received for that SDM, whereafter the percentage was calculated by dividing the SDM's score by the

maximum that an SDM can receive for all the aspects, namely 10991.00 (calculated by adding all the maximum scores of the aspects together). Scrum, for example received a total score of 4038.51. By dividing this by 10991.00, gives the suitability percentage. This can be interpreted as Scrum being 36.74% suitable for the development of a location-based game. According to Table 4-6 and **Appendix 4**, the SDM that was most suitable with a score of 63.14% was Playability and Re-playability, with Mobile-D scoring the lowest suitability with 31.60%. The table also clearly indicates that none of the SDMs chosen is 100% suitable for the development of location-based games.

Table 4-7: Framework results per SDM

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
Playability (w=8.81)	C1: 0% C2: 10% C3: 10% A1: 15%	C1: 10% C2: 20% C3: 30% A1: 20%	C1: 5% C2: 20% C3: 10% A1: 15%	C1: 5% C2: 20% C3: 10% A1: 15%	C1: 5% C2: 20% C3: 10% A1: 30%	C1: 55% C2: 50% C3: 40% A1: 20%	C1: 90% C2: 100% C3: 85% A1: 100%	C1: 60% C2: 70% C3: 40% A1: 65%	32.97%
	AVG: 8.75=> 77.09	AVG: 20=> 176.2	AVG: 12.5=> 110.13	AVG: 12.5=> 110.13	AVG: 16.25=> 143.16	AVG: 41.25=> 363.41	AVG: 93.75=> 825.94	AVG: 58.75=> 517.59	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

In Table 4-7 a similar calculation was used to calculate the degree to which all the SDMs on average in the current framework address the different aspects. For example, user interface design has a weight of 7.67. By multiplying this with 8 (the number of SDMs used in this specific framework) and 100 (the maximum score an aspect can receive) the maximum of 5976.00 was calculated for user interface design across all the SDMs. The actual score that user interface design received, 3660.30 was divided by 5976.00 to determine the degree to which the SDMs in this framework address the aspect user interface design. It can be interpreted that the SDMs in the current framework address the aspect user interface design with a percentage of 61.25% as can be seen in Table 4-7. As can be seen in Table 4-7 the aspect, value to the player, received the highest score of 87.97% across all of the SDMs. The aspect, security and privacy, scored the lowest across all of the SDMs with a score of 20.47%. This is problematic since it is an important aspect needed in the development process of location-based games as described in the previous phase. If neither the developers nor the SDMs emphasise secure development, the players of location-based games are left in harm's way as they do not take precautions in regards to location-based

technologies, services and games. It is critical that the SDM ensures that the games developers incorporate security and privacy in the development of location-based games. Notwithstanding the fact that one of the aspects (value to the player) was addressed 87.97% across all of the SDMs, there are still a considerable number of aspects that need to be addressed by the SDMs in the development of location-based games.

Table 4-8: Framework results per aspect

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
Value to the Player (w=7.67)	C1: 80% C2: 100% C3: 50% A1: 85%	C1: 85% C2: 100% C3: 60% A1: 85%	C1: 95% C2: 100% C3: 80% A1: 80%	C1: 95% C2: 100% C3: 80% A1: 85%	C1: 95% C2: 100% C3: 80% A1: 75%	C1: 95% C2: 100% C3: 80% A1: 80%	C1: 100% C2: 100% C3: 80% A1: 95%	C1: 100% C2: 100% C3: 80% A1: 95%	87.97%
	AVG: 78.75=> 604.01	AVG: 82.5=> 632.78	AVG: 88.75=> 680.71	AVG: 90=> 690.3	AVG: 87.5=> 671.13	AVG: 88.75=> 680.71	AVG: 93.75=> 719.06	AVG: 93.75=> 719.06	
User Interface Design (w=7.47)	C1: 10% C2: 10% C3: 30% A1: 20%	C1: 50% C2: 60% C3: 55% A1: 55%	C1: 90% C2: 80% C3: 80% A1: 75%	C1: 0% C2: 10% C3: 50% A1: 20%	C1: 80% C2: 80% C3: 80% A1: 75%	C1: 90% C2: 90% C3: 80% A1: 85%	C1: 50% C2: 100% C3: 80% A1: 65%	C1: 100% C2: 100% C3: 25% A1: 85%	61.25%
	AVG: 17.5=> 130.73	AVG: 55=> 410.85	AVG: 81.25=> 606.94	AVG: 20=> 149.4	AVG: 78.75=> 588.26	AVG: 86.25=> 644.29	AVG: 73.75=> 550.91	AVG: 77.5=> 578.93	
Security and Privacy (w=7.11)	C1: 100% C2: 80% C3: 50% A1: 80%	C1: 0% C2: 10% C3: 10% A1: 15%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 55% C2: 50% C3: 30% A1: 40%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 25% C3: 10% A1: 10%	20.47%
	AVG: 77.5=> 551.03	AVG: 8.75=> 62.21	AVG: 5=> 35.55	AVG: 7.5=> 53.33	AVG: 43.75=> 311.06	AVG: 5=> 35.55	AVG: 5=> 35.55	AVG: 11.25=> 79.99	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

By evaluating the results of the framework, it is clear that there is a number of inadequacies in the available SDMs. The framework proves this by indicating that the highest suitability percentage for any of the SDMs was 63.85%. Although the highest scoring aspect across all the SDMs in this framework scored 87.97%, there is still a number of inadequacies that needs to be addressed in the development of location-based games.

4.5. Summary

In this phase of the development of the DMLBG the development of a framework that can be used to evaluate SDMs' suitability in aiding the development of location-based games was proposed. The development of this framework is important due to the fact that to the researcher's knowledge there are no frameworks, mechanisms, tools or techniques that can be used to do this evaluation. Secondly, this is also important because to the researcher's knowledge there are no SDMs that are specifically designed for the development of location-based games. To be able to develop this framework, four sub-objectives for this phase were set. The first was to identify aspects that need to be addressed during the development of location-based games. These aspects were identified from the literature and formed the evaluation criteria that the framework used. Specifically, the security and privacy aspects were identified from the literature, as well as from the previous phase. The results of the previous phase were incorporated in this phase to ensure that one of the key aspects in evaluating the suitability of SDMs to aid in location-based games development was security and privacy. The second sub-objective was met by using the aspects in a survey to gather information from the gaming industry to determine how important each aspect is. Furthermore, this survey also gave the participants the ability to add aspects if any were neglected. After the survey was analysed, the framework was developed in order to achieve the third sub-objective. The fourth sub-objective was achieved by using the framework to evaluate some of the most used SDMs for mobile development, mobile game development or game development. Each of the SDMs was analysed and scored by independent developers and the researcher with regard to each SDM's incorporation of each aspect. It was clear from the result of the framework that none of the SDMs evaluated was 100% suitable to aid in the development of location-based games.

It was also noted that security and privacy was not regarded as one of the most important aspects needed in the development process of location-bases games. This is troubling as it leaves the players with a big security gap. Furthermore, as mentioned in the previous phase players might not take necessary security precautions that could put them in harm's way. The framework also indicated that the aspect security scored the least across all of the SDMs. This means that the SDMs do not address security and privacy adequately enough for the development of location-based games. It is important that the development process emphasise secure development as the games developers do not rank security and privacy as one of the most important aspects.

The conclusion for this phase is discussed in Chapter 7. The next chapter will focus on the third phase of the development of the DMLBG. In this phase the focus is on using the results of the framework to identify a list of steps and techniques that can be considered during the development of the DMLBG. In this phase the DMLBG will also be developed.

Chapter 5 The development of the Developmental Methodology for Location-Based Games (DMLBG)

This phase, as well as phase 4 of the study are based on the research paper: **The development of a systems development methodology for location-based games**. The paper was submitted to the journal: **Computers in Entertainment**. Currently the status of the paper is: **Under Review**.

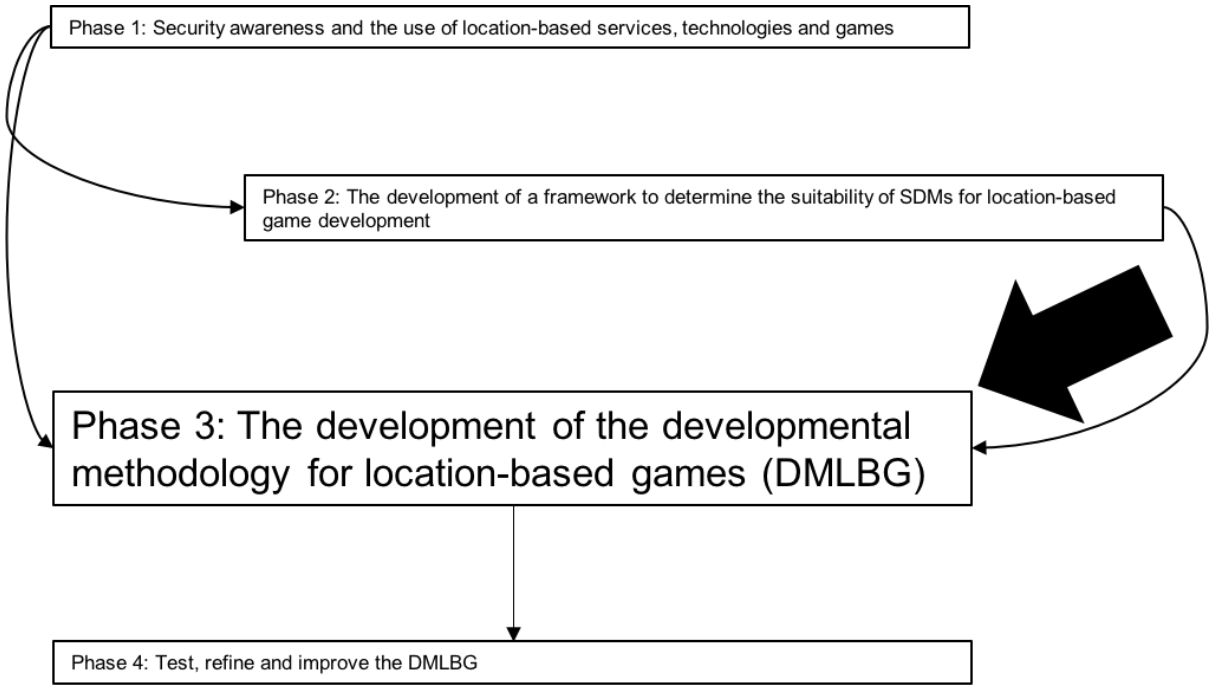


Figure 5-1: Research roadmap – phase 3

5.1. Introduction

The gaming industry is a multibillion dollar industry (Grey & Alkhafaji, 2011). Mobile games in the USA alone account for 40 percent of all game content sales since 2012 (Bowman *et al.*, 2015). Due to this rising demand, it is important for mobile games developers to use a clear, effective and efficient SDM for the design, development and distribution of mobile games.

In the last couple of years, the complexity of game development also increased exponentially (Reyno & Cubel, 2008). Aspects that contribute to the complexity of game development are amongst others a multidisciplinary development process, different specialist areas, technical challenges, tools, project size and workflow (Blow, 2004; Callele *et al.*, 2005).

As this study focuses on location-based games, the definition of a location-based game can be repeated. A location-based game is a mobile game that focuses on the player's location and incorporates it in the gameplay (Buzeto *et al.*, 2014). This allows the player to be more immersed in the game world (Buzeto *et al.*, 2014). The development of mobile games is more complicated than console or on-line games (Feijoo *et al.*, 2012). This is because mobile games incorporate different dimensions that are usually not included in console or on-line games (Feijoo *et al.*, 2012).

Despite the rapid growth of the gaming industry and the high complexity of mobile game development, there is still no specialised SDM for the development of mobile games and more specifically for location-based games. It would appear that most games developers rely on *ad hoc* development, agile development, component-based development and software product lines (Reyno & Cubel, 2008; Keith, 2010). This indicates that the developers do not use a specialised SDM that can aid in the development of mobile and location-based games.

Therefore, in this phase (Figure 5-1) the focus will be on developing an SDM called the Developmental Methodology for Location-Based Games (DMLBG). The aim of the DMLBG is to aid in the development of location-based games. The DMLBG will be utilised to develop four location-based games. Based on the developers' and projects managers' experience using the DMLBG (this will be done in the next phase), the DMLBG will be refined and improved.

The sub-objective of this phase will be discussed in section 5.2, whereafter the theoretical background will be discussed in section 5.3. In section 5.4 the application of the suitability framework, as well as the results of applying this framework will be discussed. In section 5.5 the DMLBG will be presented, followed by the summary of this phase in section 5.6.

5.2. Sub-objective

In this phase an SDM that is better suited to aid in the development of location-based games will be developed. The sub-objective for this phase is:

1. Develop an SDM that can aid in the development of location-based games.

5.3. Theoretical background

The rapid expansion and use of mobile technology and the development of new and creative games led to the development of location-based games (Ardito *et al.*, 2010). This is primarily due to Smartphones having the capabilities of integrated peripherals, such as GPS (Ardito *et*

al., 2010). The development of location-based games is complex and for this reason it is necessary to explore the possibility that a specialised SDM can aid in the development process. As previously stated, the researcher is not aware of any specialised SDMs that are able to address all the aspects needed for the development of a location-based game.

Firstly, the organisational departments and teams needed for developing a location-based game will be discussed. This will be an elaboration on the aspect organisational structure from the previous phase. As most games are developed by teams with members from different departments a more in depth description of the different members are going to be given.

Secondly, in this phase some of the SDMs that are usually associated with the development of games, mobile games and mobile applications and which were described in the previous phase will be used to developed the new SDM.

Thirdly, a discussion of the suitability framework, developed to determine the suitability of SDMs to aid in the development of location-based games, is included. Based on the result of the previous phase, the DMLBG will be developed and tested.

5.3.1. Organisational departments and development team

The fact that games are complex to develop also holds true for a game development company's organisational structure. To develop a game, different types of specialist are needed (Deuze *et al.*, 2007). These specialists can include programmers, network, sound, graphics and business-type specialists (Cohendet & Simon, 2007; Deuze *et al.*, 2007; Novak, 2011:319-360). Each of these specialists can be in a different department of the organisation. For different specialists from different departments to work together as one team to achieve success, is a major challenge (Deuze *et al.*, 2007). For a location-based game, different departments, as well as specialists associated with these departments, have been identified and will be kept in mind in the development of the new SDM as part of the organisational aspect from the previous phase.

1. Core Programming: The programmers are responsible for constructing algorithms. The programmers are also responsible for integrating the other departments' outputs. This means that the programmer will convert the outputs of the other departments into algorithms (Deuze *et al.*, 2007; Novak, 2011:332-337).

2. Networking: This department consists of network engineers. These engineers are responsible for the development, setup and testing of the network and communication that is needed for a location-based game (Novak, 2011:333).

3. Graphics: The graphics department consists of various types of specialist, such as artistic or graphics designers and graphics programmers. The graphics designer specialist is responsible for drawing the graphics, which are needed for the game, whereas the graphics programmers convert the drawings into digital images and models. These images and models are then programmed and handed over to the programming department (Cohendet & Simon, 2007; Novak, 2011:323-331).

4. Sound: The sound department consists of sound engineers. The sound engineers are responsible for creating the sound that is needed for the game. The music and the various sound effects need to be encoded and converted so that the programmers can integrate the sound into the game (Cohendet & Simon, 2007; Deuze *et al.*, 2007; Novak, 2011:338-339).

5. Business: The business department usually consists of managers, designers and marketing specialists. The responsibility of these specialists is to manage the game development, to aid in the designing of the game and to run marketing campaigns for the game (Novak, 2011:319-360).

6. Testing: The testing department is responsible for testing the game. The testers play the game and make suggestions to the programmers based on playability, re-playability, experience, challenge, mastery and errors. A typical testing department consists of beta and quality-assurance testers. This will ensure that the game is tested on different levels (Novak, 2011:340-341).

5.3.2. Systems development methodologies and methods

The SDMs from the previous phase are going to be used in this phase to develop the new SDM. The theory of SDMs, as well as each of these SDMs were discussed in depth in the previous phase, therefore only a brief summary of each of these SDMs will be given here. The SDMs are:

1. Traditional SDLC: The SDLC was one of the first SDMs used to develop information systems. This SDM was later adapted and used to develop games with limited success. There are different versions for this SDM. For this study two

versions, consisting of seven and ten phases respectively, were chosen. the phases are clearly defined and executed in sequence (Royce, 1970; DOJ, 2003; Avison & Fitzgerald, 2006:31-44).

2. Scrum: The Scrum framework is part of the agile SDM family along with Extreme Programming and Feature Driven Development. These SDMs are exactly the opposite of the SDLC. The major difference is that Scrum focuses on practical applications and flexibility. To elaborate on these issues, Scrum was created to be a management and control tool to reduce complexity. In addition, Scrum focuses on building software applications that will satisfy business requirements (Keith, 2010).

3. MASAM: Mobile Application Software Based on Agile Methodology (MASAM) is an agile SDM that focuses on rapid application development. The key goal of this SDM is simple development and fast deployment of new mobile applications. To achieve this goal, emphasis on copious involvement of the user in the development process is required. (Jeong *et al.*, 2008).

4. Mobile-D: Mobile-D is based on Extreme Programming, Crystal Methodologies and Rational Unified Process and is considered to be an agile development approach. This SDM focuses on developing a mobile application in the shortest possible time. To accomplish the shortest possible development time, the SDM requires a team of less than 10 people in a single room. The sole purpose of this team is rolling out a fully functional mobile application as fast as possible, usually not longer than ten weeks (Abrahamsson *et al.*, 2004).

5. RAD with DSDM Atern: Rapid Application Development (RAD) focuses on developing and delivering high quality systems in the shortest possible time and at the lowest cost. RAD was implemented as a new methodology RAD Dynamic Systems Development Method (DSDM). DSDM is a framework that is based on the best practices and lessons learned and extended the original RAD methodology to RAD DSDM Atern. This SDM focuses on software to be developed in an agile environment (Beynon-Davies & Holmes, 2002; DSDM-Consortium, 2008).

6. MDA Framework: Mechanics, Dynamics and Aesthetics framework (MDA) focuses on designing games by breaking the game down into its distinct

components; that is rules that lead to the system and in turn lead to fun. After the components have been identified, their counterparts for designing the game are identified, namely mechanics that lead to dynamics and in turn lead to aesthetics. The fundamental idea of MDA is that games are more like artefacts than like media. The argument behind this is that thinking about games as designed artefacts helps frame them as a system that can be designed and developed by using a formal approach. MDA identifies each component as a lens or a view from which different spectators view the component. The designer of the game views the mechanics, dynamics and aesthetics, whereas the player views the rules, system and fun (Hunicke *et al.*, 2004).

7. Playability and Re-playability: A design SDM for games that is based on playability and re-playability is proposed in this section. This SDM is based on the design process of the two key factors that contribute to the success of a game, namely playability and re-playability. Playability and re-playability can be described in terms of six aspects, namely social reasons, challenge, experience, mastery, impact, and completion. These six aspects of playability and re-playability are used to weigh game features and to adjust the design process of the SDM (Krall & Menzies, 2012).

8. Player-centred game design: The basis for this method is that games differ from business applications in that a business application is developed to satisfy the requirements that the client requested, whereas games are not developed to satisfy the requirements of a client. This complicates the development process in that the game should satisfy different types of game requirement without having been specifically developed for a specific group of direct clients. This is why this method of game design focuses on the players of the game. The method identifies four distinct stages of game development, namely concept development, pre-production, production and post-production (Sykes & Federoff, 2006).

5.4. Using the Suitability framework to aid in the development of the DMLBG

The result from analysing these SDMs with the framework in the previous phase will be used in the development of the DMLBG. A summary of the results from the suitability analysis is given in Table 5-1 and Table 5-2.

Table 5-1 indicates the suitability of each SDM with regard to aiding in the development of location-based games. This was calculated by determining the average of the extent to which each SDM addresses each of the aspects needed for a location-based game.

Table 5-1: The suitability of each SDM for developing location-bases games

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%

Table 5-2 shows to what degree all the SDMs addressed each of the aspects. This was calculated by determining the average each SDM addressed the specific aspect. It is clear from these two tables that none of these SDMs is 100% suitable for the development of a location-based game.

Table 5-2: The suitability that each aspect scored

	Aspects	Suitability of aspects across SDMs
1.	Playability	32.97%
2.	Player Experience	81.91%
3.	Usability	73.31%
4.	Value to the Player	87.97%
5.	User Interface Design	61.25%
6.	Development Team	60.31%
7.	Re-Playability	35.47%
8.	Learnability	35.16%
9.	Efficiency	21.56%
10.	Security and Privacy	20.47%
11.	Availability and Accessibility	24.06%
12.	Cognitive Support	54.22%
13.	Compatibility	28.75%
14.	Adaptability	50.94%
15.	Organisational Structure	57.66%

5.4.1. Steps and techniques identified by using the Suitability framework

In this section the steps and techniques from each SDM in the suitability analysis that can be considered for inclusion in the DMLBG are discussed. These steps and techniques will be

grouped per aspect to indicate which ones address the specific aspect. Each of the identified steps or techniques is derived from the strengths identified for each SDM in the suitability analysis. Furthermore, the steps and techniques that are most suitable to aid in the development of a location-based game for each aspect were chosen to be included in the DMLBG. This means that not all the steps and techniques in the list will be in the DMLBG. The **bolded** SDM is the main SDM from which the steps and techniques were derived and the rest of the SDMs in *italic* support the step and technique in some way. As an example for the aspect playability one of the steps and techniques identified was "Six aspects of playability". The main SDM that this was derived from was **Playability and Re-playability**. The supporting SDMs included *MDA Framework* and *Player-centred game design*.

5.4.1.1. Playability

Steps and techniques that are associated with playability are:

- Six aspects of playability: *MDA Framework,* **Playability and Re-playability***, Player-centred game design*
- List game features and estimate scores based on playability: *MDA Framework,* **Playability and Re-playability***, Player-centred game design*
- Adjust game according to scores to fit a specific category: **Playability and Re-playability**
- Iteratively developing a dynamic model: **MDA Framework***, Playability and Re-playability, Player-centred game design*
- Refine the player audience: *MDA Framework, Playability and Re-playability,* **Player-centred game design**
- Player feedback for next game or to make game more playable: *MDA Framework, Playability and Re-playability,* **Player-centred game design**

5.4.1.2. Player Experience

The SDMs used the following to incorporate player experience:

- Involve players: *SDLC,* **MASAM***, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design*
- Use similar games as guidelines: *SDLC, MASAM,* **Mobile-D***, RAD with DSDM Atern*
- Requirements gathering: **SDLC***, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Player-centred game design*

- User interface and non-functional requirements analysis: **SDLC**, *MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design*
- Prototype the user interface to the player: **MASAM***, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design*
- Test on prospective player: *SDLC, MASAM,* **Mobile-D***, RAD with DSDM Atern, MDA Framework, Player centred-game design*
- Iteratively develop aesthetics model: **Playability and Re-playability**
- Use six aspects of playability and re-playability: **Playability and Re-playability**
- Try to satisfy all types of gamers: **Player-centred game design**
- Assume that the game does not have only one client: **Player-centred game design**
- Design for experience: **Playability and Re-playability**

5.4.1.3. Usability

The following steps and techniques are used by the SDMs to facilitate usability:

- Design the game interface: *SDLC, MASAM, RAD with DSDM Atern,* **MDA Framework***, Playability and Re-playability*
- Create prototypes to present to a player group: **MASAM**, RAD with DSDM Atern
- Modify the application according to user feedback: *SDLC,* **MASAM***, RAD with DSDM Atern, MDA Framework*
- Repeat the process until the players are satisfied: *MASAM, RAD with DSDM Atern,* **MDA Framework***, Playability and Re-playability, Player-centred game design*
- List game features: **Playability and Re-playability**
- Estimate scores for game features: **Playability and Re-playability**
- Adjust game features based on scores: **Playability and Re-playability**

5.4.1.4. Value to the Player

Steps and techniques that focus on adding value to the player are:

- Collection of player requirements: **SDLC***, Scrum, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design*
- Presentation of intermediate products: **Scrum***, Mobile-D, MDA Framework, Player-centred game design*

- Player feedback: *SDLC, Scrum, MASAM, Playability and Re-playability,* **Player-centred game design**
- Aesthetics model: **MDA Framework**
- Dynamic model: **MDA Framework**
- Mechanic model: **MDA Framework**
- Six aspects of playability and re-playability: **Playability and Re-playability**
- Developers should also refine the player audience: **Player-centred game design**
- Concept design for different players: **Player-centred game design**

5.4.1.5. User Interface Design

The steps and techniques that focus on user interface design are the following:

- Player involvement: *MASAM,* **RAD with DSDM Atern***, MDA Framework, Player-centred game design*
- Aesthetics model design: **MDA Framework**
- Iteratively tuning aesthetics model: **MDA Framework**
- Production that keeps the different types of players in mind: **Player-centred Game Design**
- Post-production that used player feedback for next project: *RAD with DSDM Atern, MDA Framework,* **Player-centred game design**
- Continued involvement of the players: **RAD with DSDM Atern**

5.4.1.6. Development Team

Steps and techniques that support development teams are:

- Agile development environment: **Scrum, RAD with DSDM Atern**
- Development process cannot be planned from beginning to end: **Scrum, RAD with DSDM Atern**
- Feasibility study with all departments: *Scrum, Mobile-D,* **RAD with DSDM Atern**
- Concept development with entire team (all departments): **Scrum***, RAD with DSDM Atern*
- Pre-production design session for entire team to finalise design: *Scrum, Mobile-D, Rad with DSDM Atern,* **Player-centred game design**
- Product sharing and environmental setup: *Scrum,* **RAD with DSDM Atern***, Player-centred game design*
- Extreme programming elements: **RAD with DSDM Atern**
- Crystal methodologies elements: **RAD with DSDM Atern**

- Rational Unified Process elements: **RAD with DSDM Atern**

5.4.1.7. Re-playability

Steps and techniques that are associated with re-playability are:

- Six aspects of playability: *MDA Framework,* **Playability and Re-playability**, *Player-centred game design*
- List game features and estimate scores based on playability: *MDA Framework,* **Playability and Re-playability**, *Player-centred game design*
- Adjust game according to scores to fit a specific category: *MDA Framework,* **Playability and Re-playability**, *Player-centred game design*
- Iteratively developing a dynamic model: **MDA Framework**, *Playability and Re-playability, Player-centred game design*
- Refine the player audience: *MDA Framework, Playability and Re-playability,* **Player-centred game design**
- Player feedback for next game or to make game more playable: *MDA Framework, Playability and Re-playability,* **Player-centred game design**

5.4.1.8. Learnability

Steps and techniques that accommodate learnability are the following:

- Feedback and suggestions from the players: *MASAM,* **RAD with DSDM Atern**, *MDA Framework, Playability and Re-playability, Player-centred game design*
- Requirements gathering: **SDLC**, *MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Player-centred game design*
- Performance management: *MASAM,* **RAD with DSDM Atern**
- Prototyping: **MASAM**, *RAD with DSDM Atern*
- Player involvement: *MASAM,* **RAD with DSDM Atern**, *MDA Framework, Playability and Re-playability, Player-centred game design*
- Iteratively developing the aesthetics of the game: **Playability and Re-playability**
- Focus on playability and re-playability: **Playability and Re-playability**
- Take into account that there are different types of gamers: **Player-centred game design**

5.4.1.9. Efficiency

Steps and techniques associated with efficiency are the rigorous execution of the design, development and integration and testing phases from the **SDLC**.

5.4.1.10. Security and Privacy

Steps and techniques associated with security and privacy are the rigorous execution of the design, development and integration and testing phases from the **SDLC**.

5.4.1.11. Availability and Accessibility

Steps and techniques that are included in these SDMs to add availability and accessibility to their scope are:

- Market-centred deployment: *MASAM*, **RAD with DSDM Atern**
- Focus on how the market plays a role in the game's success: *MASAM*, **RAD with DSDM Atern**

5.4.1.12. Cognitive Support

The following steps and techniques are used by SDMs to facilitate cognitive support:

- Thorough interface planning: *SDLC, MASAM,* **MDA Framework***, Playability and Re-playability, Player-centred game design*
- Involvement of game players: *SDLC, MASAM, Playability and Re-playability,* **Player-centred game design**
- Iteratively designing an aesthetics model: **MDA Framework**
- Iteratively tuning an aesthetics model: **MDA Framework**
- Designing for completion: **Playability and Re-playability**

5.4.1.13. Compatibility

Steps and techniques that are associated with compatibility are:

- Release and deployment planning: *SDLC,* **Mobile-D**
- Identify devices and platforms for deployment: *SDLC,* **Mobile-D**

5.4.1.14. Adaptability

Steps and techniques that address adaptability in these SDMs are:

- Feedback and suggestions from players: *SDLC, MDA Framework,* **Player-centred game design**
- Iterative development of a dynamic model: **MDA Framework**
- Iterative development of a mechanic model: **MDA Framework**

- Determine the game's category and adjust game accordingly: **Playability and Re-playability**
- Re-playability factors: **Playability and Re-playability**
- Concept development: **Playability and Re-playability***, Player-centred game design*

5.4.1.15. Organisational Structure

Steps and techniques that are associated with organisational structure are:

- Agile development environment: **Scrum, RAD with DSDM Atern**
- Development process cannot be planned from beginning to end: **Scrum, RAD with DSDM Atern**
- Feasibility study with all departments: *Scrum,* **RAD with DSDM Atern**
- Concept development with entire team (all departments): *Scrum,* **RAD with DSDM Atern**
- Pre-production design session for entire team to finalise design: *Scrum, RAD with DSDM Atern,* **Player-centred game design**
- Product sharing and environmental setup: *Scrum,* **RAD with DSDM Atern***, Player-centred game design*
- Extreme programming elements: **RAD with DSDM Atern**
- Crystal methodologies elements: **RAD with DSDM Atern**
- Rational Unified Process elements: **RAD with DSDM Atern**

5.5. The development of the DMLBG

A complete discussion on the design science research method used for this phase was provided in Chapter 2. As mentioned, the newly developed SDM is called the Developmental Methodology for Location-Based Games (DMLBG). The DMLBG will be developed using the steps and techniques identified in the previous section of this phase. The discussion of the DMLBG will be divided into the four main components of SDMs, namely philosophical approach, method, process model and tools and techniques. Figure 5-2 demonstrates how the development of the DMLBG was done. As can be seen from this figure, the aspects were used to develop the suitability framework. The suitability framework was then used to analyse the SDMs. Based on the suitability analysis, the suitability of, as well as the strengths that each SDM has in aiding the development of location-based games were identified. Based on this, a list of steps and techniques was constructed, from which the final steps and techniques to be included in the DMLBG were chosen. The selection process of steps and techniques to be included in the DMLBG was done based on the scores that the

SDMs obtained from the suitability analysis. Most of the steps and technique included in the DMLBG were from the highest scoring SDM for that specific aspect, while in some cases a step and technique was chosen from the SDM that scored second or third best for the specific aspect. This was done if the step and technique from the SDM that scored the most were already included or if the step and technique from the SDM that scored a little less could add more value to the DMLBG.

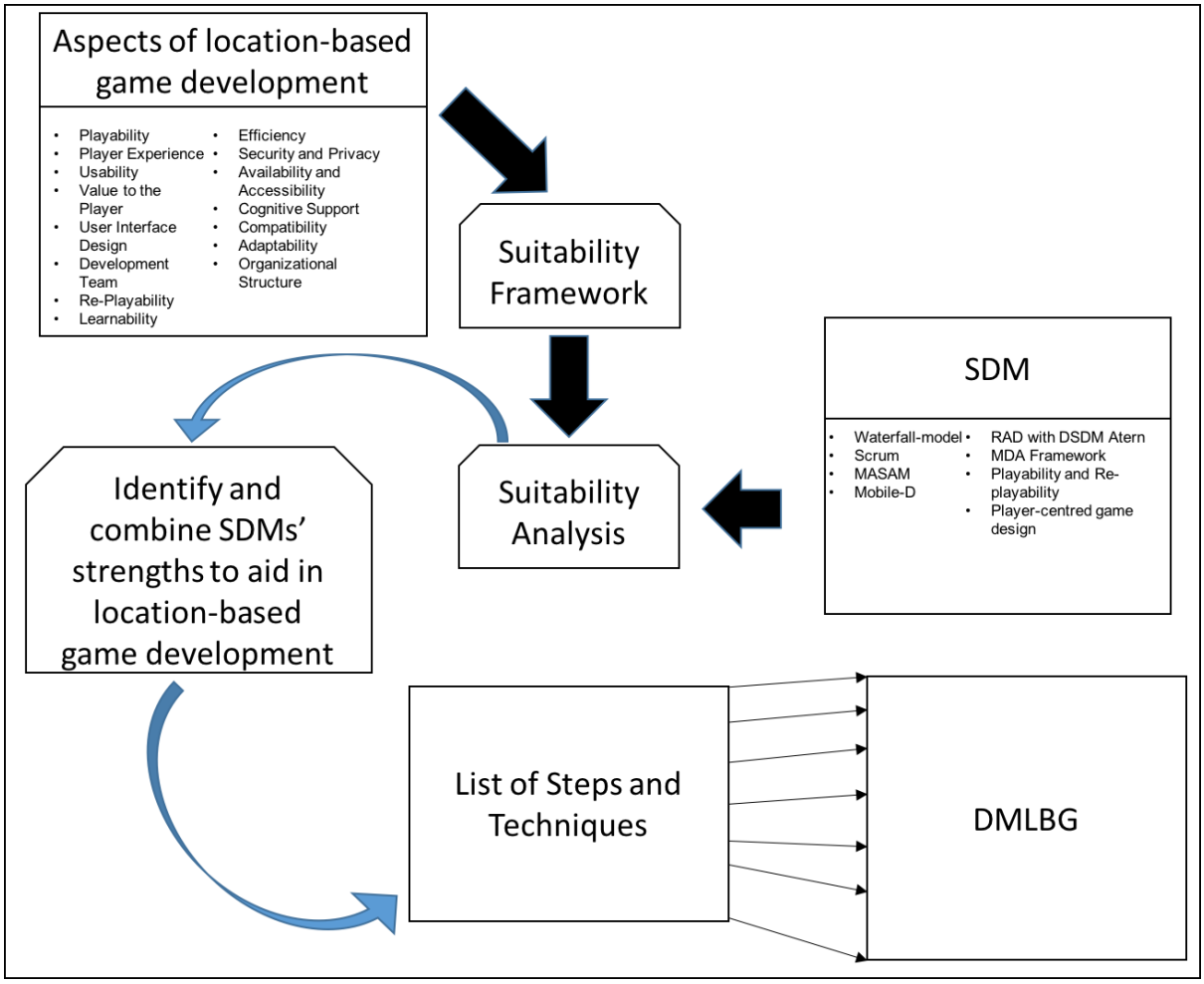


Figure 5-2: Development of the DMLBG

5.5.1. Philosophical approach

The philosophical approach of the DMLBG is to reduce the complexity of developing a location-based game. Furthermore, the DMLBG strongly focuses on integrating different specialists needed for developing a location-based game. The DMLBG allows the specialists from different departments to work together. This is facilitated by using paired integration where specialists collaborate in pairs to combine their individual subsections to form a new subsection for subsequent iterations of paired integration. This process is repeated until the integrated prototype is constructed. After the integrated prototype is constructed, the newly

formed integrated prototype should be tested. This concept is called the integrated testing for the DMLBG. The DMLBG also supports agile development to promote change in the development process. The result from the first phase that indicated that necessary precautions are not taken to prevent security infringement also needs to be incorporated in the philosophy of the DMLBG. The secure development of location-based games therefore needs to be addressed.

In summary, the philosophical approach of the DMLBG is to develop a location-based game by increasing the development efficiency and agile development and reducing the complexity resulting from the collaboration of different departments by using paired integration and integrated testing while emphasising secure development.

5.5.2. Process Model

Figure 5-3 shows a graphical representation of the process model of the DMLBG.

The process model of the DMLBG was constructed by analysing the best practices from each of the chosen SDMs. Each of the SDMs' best practices in their process models were combined to form the process model of the DMLBG. The process model for the DMLBG consists of 10 phases, each with a number of steps that need to be executed. Phases one to three and their steps are executed incrementally. The steps of phase four are parallel and iterative in nature. Phases five to seven are executed iteratively with the possibility of referring back to phase four as an additional step in the iteration. Phases five and six once again have parallel and iterative steps whereas phases eight to ten are executed incrementally to complete the developmental process. The phases that are iterative will be discussed below.

Phase four allows for the development of a framework which includes the design of the different specialists' department. These designs will be developed in parallel and integrated to form a framework that depicts the design of the overall game development. The development and integration of the framework will be iterative until the entire team has signed off. The rest of the steps for phase four will be incremental.

Phase five has a step called development, which is iterative. This step is where the game is developed. The step will start by developing a prototype if there is not a prototype to work from. Each of the specialists will develop his/her prototype individually. When each member of the team finishes his or her prototype, the paired integration process will begin. Each member teams up with another member to integrate their individual prototypes into one. Each of these prototypes is then integrated with each of the others until a single integrated

prototype, which consists of all of the individual prototypes, has been developed. The integrated prototype is then handed over to be tested and at the same time the prototype will be used for the next iteration of the step. The tester will conduct the integration testing of phase six to ensure that the prototype is working and submit the problems to the beginning of the development phase so that the changes can be made at the beginning of the next iteration. This process will be executed iteratively until a playable prototype of the game is available. Then the process will include alpha and beta testing in the same way as integration testing.

Phase seven is in itself incremental but can cause iteration. This phase relies on the six principles of playability and re-playability. These six aspects are applied and if there are any changes that need to be made, the development process can revert back to either phase four or phase five, depending on the changes that need to be made.

The steps in phase eight are incremental, but the marketing campaign step occurs throughout the development process. The reason this step is included in this phase is that it ends in phase eight. From the beginning of the development process, all the sub-steps associated with the marketing campaign will occur and interact with all the phases and steps up to phase eight.

In summary, the process model for the DMLBG is phases and steps that are incremental and iterative.

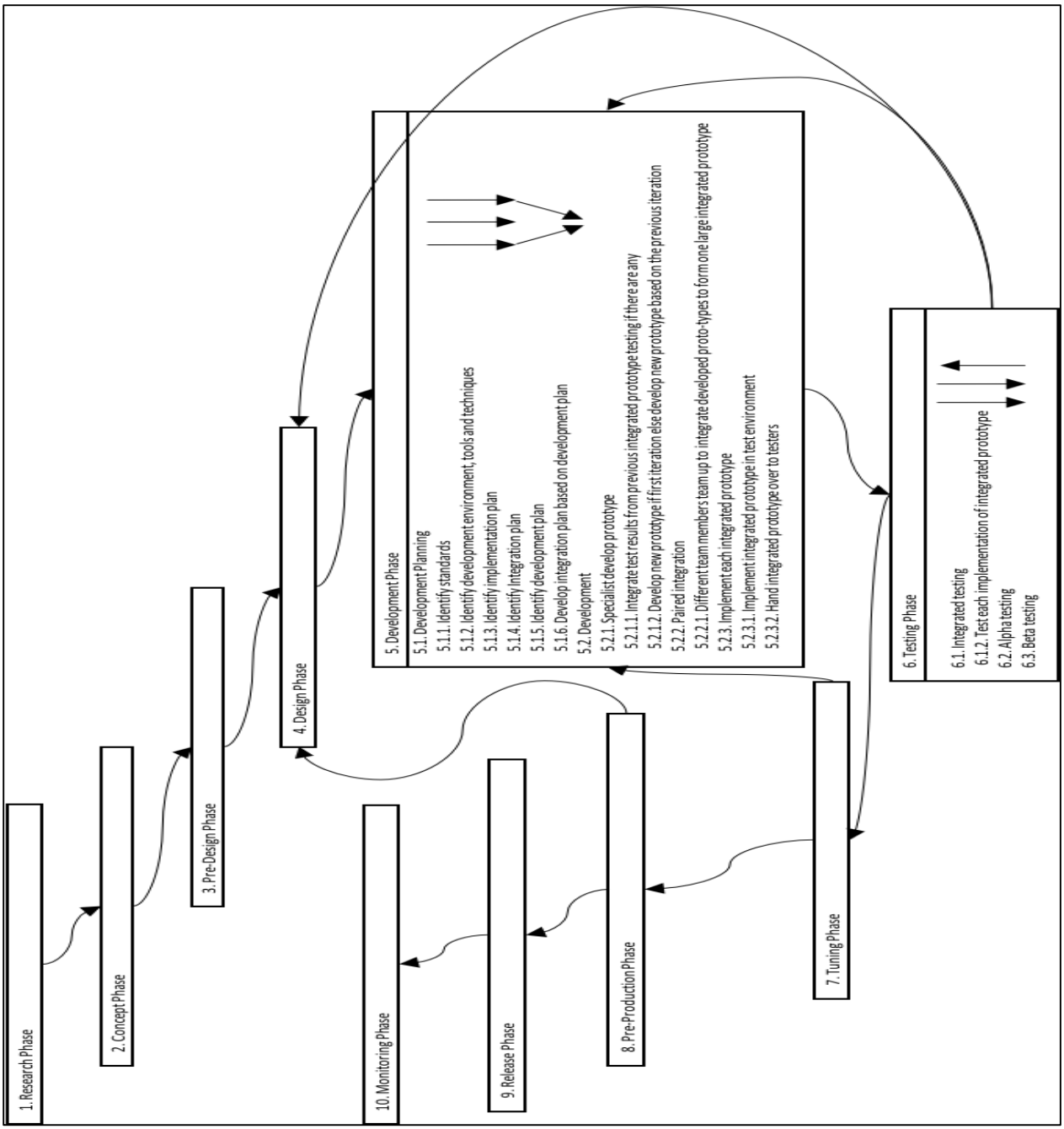


Figure 5-3: Process model of the DMLBG

5.5.3. Method

The method that includes all the phases and steps for the DMLBG are presented below. Each of the steps or phases in the method supports one or more aspects, which are listed in brackets. The steps or phases that do not have this reference to an aspect are newly developed to enhance the development process. The detailed mapping of the identified aspects, steps and techniques to the method of the DMLBG is given in **Appendix 5**.

1. Research Phase

1.1. **Decide initial concept of game** (Player Experience, Usability, Value to the Player)

Identify requirements needed for the development of the location-based game. Translate the requirements to a list of features that is needed in the game. Ensure that the game will satisfy different levels of gamers. Start with a concept design for the aesthetic model of the location-based game.

1.2. **Identify key specialists for initial phases** (Organisational Structure, Development Team)

The identification of specialists who are needed to execute phases one and two. Usually a majority of management and business unit team members are included. One or two developers can be included to assist with some technical detail.

1.3. **Concept development**

1.3.1. **List game features** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Playability, Re-playability)

Elaborate on the initial list of game features.

1.3.2. **Estimate scores for game features** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Playability, Re-playability)

Estimate the features of the game by determining the importance of each of the six aspects of playability and re-playability. The higher the score of the feature, the higher the priority of the feature to be developed.

1.3.3. **Determine game category** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Playability and Re-playability)

Determine the category and genre into which the game fits. This will ease the design of the game going forward. Use similar games to determine the category and genre as a guideline. Also focus on the role that the market plays in different game categories and genres. Keep in mind the platforms on which the location-based game needs to be deployed.

1.3.4. **Adjust game concept** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Playability, Re-playability)

Adjust the initial game concept to fit the category and genre that was identified.

1.4. **Market research** (Value to the Player, Availability and Accessibility, Adaptability, Compatibility, Efficiency)

Match the player requirement with similar games already deployed in the market place. Update the requirements as needed. Include the requirements needed for deployment to the specific on-line store/platform for which the location-based game is intended.

1.5. **Research accuracy of game concepts** (Player Experience, Usability, Cognitive Support, Value to the Player, Efficiency)

Ensure that the game concept aligns with the category and genre chosen for the location-based game. Ensure that all the above steps are aligned with real-world examples (location-based games already developed).

2. Concept Phase

2.1. **Feasibility study**

2.1.1. **Determine feasible solution** (Availability and Accessibility, Adaptability, Compatibility, Efficiency)

Determine if the location-based game is a viable product. If the location-based game is viable determine a feasible solution for the project to determine what benefits will likely be presented by completing the location-based game.

2.1.2. **Identify every possible approach** (Availability and Accessibility, Adaptability, Compatibility, Efficiency)

Identify the different approaches that can be taken to develop the location-based game.

2.1.3. **Illustrate organisational factors** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Adaptability, Development Team)

Identify and illustrate organisational factors that could influence the project development.

2.1.4. **Provide playability and re-playability factors** (Playability, Re-Playability)

Identify factors in the game concept, or create factors, that will contribute to the playability and re-playability of the game.

2.1.5. **Cost analysis and planning** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Organisational Structure, Development Team)

Do cost analysis for the project, keep in mind that the project is going to be developed with an agile SDM and that the project can grow beyond the duration of development. Plan accordingly for this.

2.2. **Functionality planning**

2.2.1. **Compile revised description and adaptability specification** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Development Team)

Include the adaptability specification in the finalised feasibility study. Specifications can include the requirements for the deployment to different platforms or online markets.

2.2.2. **Factor in gameplay feedback** (Player Experience, Usability, Cognitive support, Learnability, Value to the Player, User Interface Design, Adaptability)

Add to the functional planning in gameplay feedback.

2.2.3. **Adaptability features**

2.2.3.1. **Identify different states of the game** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Adaptability Playability, Re-playability)

Identify different games states or game flow.

2.2.3.2. **Determine different game and adaptability features for each game state** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Adaptability, Playability, Re-Playability)

Determine the different adaptability features (user settings and customisations) for the different states or game flow for the game.

2.2.3.3. **Determine adaptability features for dynamic model** (Cognitive Support, Learnability, Value to the Player, Adaptability, Efficiency, Playability, Re-playability)

Determine the different adaptability features (user settings and customisations) for the dynamic model.

2.2.3.4. **Determine adaptability features for mechanic model** (Cognitive Support, Learnability, Value to the Player, Adaptability, Efficiency, Playability, Re-playability)

Determine the different adaptability features (user settings and customisations) for the mechanic model.

2.2.3.5. **Determine adaptability features for game settings** (Player Experience, Usability, Cognitive Support, Learnability, Availability and Accessibility, Adaptability, Playability, Re-playability)

Determine the different adaptability features (user settings and customisations) for game settings.

2.2.3.6. **Determine design implication for adaptability** (Availability and Accessibility, Adaptability, Efficiency)

Determine the implications for the adaptability (user settings and customisations).

2.3. **Preliminary context design**

2.3.1. **Identify resources needed for the game** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Efficiency, Security and Privacy)

2.3.2. **Identify specialists needed for the game** (Player Experience, Usability, Learnability, Value to the Player, User Interface Design, Efficiency, Security and Privacy)

2.3.3. **Identify the contextual information usage in the game** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Security and Privacy)

2.3.4. **Decide on counter-plan and action if plans or resources are not available** (Player experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Efficiency, Security and Privacy)

2.3.5. **Decide how resources will be used in the game** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User interface Design, Efficiency, Security and Privacy)

2.4. **Security**

2.4.1. **Identify game data that is sensitive** (Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

2.4.2. **Identify network packets that are sensitive** (Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

2.4.3. **Identify other security weaknesses** (Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

2.4.4. **Choose valid action for weaknesses, data and network** (Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

2.5. **Initial game flow design**

2.5.1 **Identify major cognitive process flows within the game** (Player Experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency)

2.5.2. **Develop storyboard for game flow** (Player Experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency)

2.5.3. **Determine game type and experience to navigate different process flows** (Playability, Usability, Cognitive Support, Value to the Player, User interface Design, Efficiency, Playability, Re-playability)

2.5.4. **Revise storyboard to include in-game tutorial based on previous step** (Player Experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency, Playability, Re-playability)

2.5.5. **Develop first draft of aesthetic model** (Player Experience, Usability, Value to the Player, User Interface Design, Efficiency)

2.5.6. **Present set of storyboards to testers** (Player Experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency)

2.5.7. **Present aesthetic model to testers** (Player experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency)

2.5.8. **Modify storyboards to accommodate tester input** (Player Experience, Usability, Cognitive Support, Value to the Player, User Interface Design, Efficiency)

3. Pre-design Phase

3.1. **Assemble team**

3.1.1. **Identify specialists** (Organisational Structure, Development Team)

3.1.2. **Identify organisational departments' involvement** (Organisational Structure, Development Team)

3.1.3. **Identify specialists that need to work in pairs** (Organisational Structure, Development Team)

3.2. **Exploration**

3.2.1. **Discuss requirements identified in new team** (Organisational Structure, Development Team)

3.2.2. **Discuss needs of game in new team** (Organisational Structure, Development Team)

3.2.3. **Develop functional solution** (Organisational Structure, Development Team)

Use output of the other phases and steps to develop a function solution with the new team.

3.3. **Get identified team up to date** (Organisational Structure, Development Team)

3.4. **Plan forward**

3.4.1. **Plan for the next phases** (Organisational Structure, Development Team)

3.4.2. **Integrate previous and upcoming outputs** (Organisational Structure, Development Team)

Integrate all the outputs from all the phases to this point. Also include future planning outputs that might have been done.

4. Design Phase

4.1. **Game Identity**

4.1.1. **Develop framework for game**

4.1.1.1. **Identify core programmer design** (Usability, Cognitive Support, Value to the Player, Adaptability, Efficiency, Playability, Re-playability)

4.1.1.2. **Identify graphics design** (Usability, Cognitive Support, Value to the Player, User Interface Design, Availability and Accessibility, Adaptability, Playability, Re-playability)

4.1.1.3. **Identify art design** (Usability, Cognitive Support, Value to the Player, User Interface Design, Availability and Accessibility, Adaptability, Playability, Re-playability)

4.1.1.4. **Identify network design** (Player Experience, Usability, Cognitive Support, Value to the Player, User interface Design, Availability and Accessibility, Playability and Re-playability)

4.1.1.5. **Identify sound design** (Usability, Cognitive Support, Value to the Player, User interface Design, Availability and Accessibility, Adaptability, Playability and Re-playability)

4.1.1.6. **Identify security design** (Player Experience, Usability, Value to the Player, Cognitive Support, Compatibility, Efficiency, Security and Privacy)

4.1.1.7. **Identify AI design** (Player Experience, Usability, Cognitive Support, Value to the Player, Efficiency, Security and Privacy, Playability and Re-playability)

4.1.2. **Integrate design from different specialists**

4.2. **Analyse game framework with entire team**

4.3. **Design Planning**

4.3.1. **Refine cost and design implications** (Availability and Accessibility, Adaptability, Efficiency, Organisational Structure, Development Team)

Revise previous cost analysis and planning and update accordingly with new information from specialists.

4.3.2. **Determine different platforms for deploying game** (Availability and Accessibility, Adaptability, Compatibility, Efficiency)

4.3.3. **Compile compatibility list** (Availability and Accessibility, Adaptability, Efficiency, Compatibility, Efficiency)

Finalise the various platforms and on-line stores that are going to be supported.

4.4. **Design**

4.4.1. **Implement logical design according to specifications**

4.4.2. **Implement physical design according to specifications**

5. Development Phase

5.1. **Development Planning**

5.1.1. Identify standards (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

Different specialists should identify standards for the development process. This can include code standards, artwork standards, network standards and security standards.

5.1.2. **Identify development environment, tools and techniques** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

5.1.3. **Identify implementation plan** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

5.1.4. **Identify integration plan** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

5.1.5. **Identify development plan** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

5.1.6. **Develop integration plan based on development plan** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

5.2. **Development**

5.2.1. **Specialist develop prototype**

5.2.1.1. **Integrate test results from previous integrated prototype testing if there are any**

5.2.1.2. **Develop new prototype for first iteration or develop new prototype based on the previous iteration**

5.2.2. **Paired integration**

5.2.2.1. **Different team members team up to integrate developed prototypes to form one large integrated prototype**

5.2.3. **Implement each integrated prototype**

5.2.3.1. **Implement integrated prototype in test environment**

5.2.3.2. **Hand integrated prototype over to testers**

6. Testing Phase

6.1. **Integrated testing**

6.1.2. **Test each implementation of integrated prototype** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Playability, Re-playability)

6.2. **Alpha testing** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Playability, Re-playability)

Testers and developers test together.

6.3. **Beta testing** (Player Experience, Usability, Cognitive Support, Learnability, Value to the Player, User Interface Design, Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Playability, Re-playability)

Testers and prospective gamers test together.

7. Tuning Phase

7.1. **Analyse problems identified in testing**

7.2 **Analyse tester or closed beta player's feedback**

7.3 **Apply six aspects of playability and re-playability** (Playability, Efficiency, Playability, Re-playability)

7.3.1. **Tuning based on social reasons**

Make changes based on social reasons to ensure that the game will be more playable and re-playable.

7.3.2. **Tuning based on completion**

Make changes based on completion of location-based game to ensure that the game will be more playable and re-playable.

7.3.3. **Tuning based on experience**

Make changes based on player experience to ensure that the game will be more playable and re-playable.

7.3.4. **Tuning based on challenging**

Make changes based on level of challenge the player experienced to ensure that the game will be more playable and re-playable.

7.3.5. **Tuning based on mastery**

Make changes based on the level of satisfaction the player gets when mastering a portion in the game to ensure that the game will be more playable and re-playable.

7.3.6. **Tuning based on impact**

Make changes based on the impact the location-based game left on the player to ensure that the game will be more playable and re-playable.

7.4. **Redesign development plan**

Make changes to the development plan based on the tuning of current version to ensure that the six aspects of playability and re-playability will be applied in future version of prototyping.

8. Pre-production Phase

8.1. **Marketing campaign (integrated in phases 1-8)**

8.1.1. **Design game name**

8.1.2. **Design game logo**

8.1.3. **Design marketing campaign**

8.1.4. **Develop game branding**

8.2. **Finalise game branding**

8.3. **Finalise game marketing campaign**

8.4. **Finalise tuning**

Finalise the tuning of the marketing campaign and game branding. Keep tuning and finalising releases of the pre-production as phases of the game continues and more media of the developed location-based game becomes available.

9. Release Phase

9.1. **Support**

9.1.1. **Set up support for the different platforms** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

9.1.2. **Set up support channels** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

9.1.3. **Implement support communication channels** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

9.1.4. **Implement support team** (Availability and Accessibility, Adaptability, Compatibility, Efficiency, Security and Privacy, Organisational Structure, Development Team)

9.2. **Pre-release**

9.2.1. **Ensure game is ready for deployment on all platforms**

9.2.2. **Ensure deployment for each platform market is understood**

9.3. **Deploy game**

10. Monitoring Phase

10.1. **Allow players to give feedback in-game** (Player Experience, Usability, Cognitive Support, Value to the Player, Playability, Re-playability)

10.2. **Set up different social media channels for player feedback** (Player Experience, Usability, Cognitive Support, Value to the Player, Playability, Re-playability)

5.5.4. Tools and techniques

The tools and techniques that the DMLBG uses for developing a location-based game are research, game category scoring, storyboards, feasibility study, identifying teams, parallel game design, parallel development, paired integration, alpha and beta testing, backwards stepping, marketing campaign, game branding, support and tutorials, and user feedback.

5.6. Summary

In this phase of the study the focus was on using the results of the suitability analysis conducted in the previous phase to develop a more suitable SDM to aid in the development of location-based games. The result of the suitability analysis showed that none of the chosen SDMs was 100% suitable for aiding in the development of location-based games.

The Development Methodology for Location-based Games (DMLBG) was developed by choosing a combination of the identified steps and techniques. This list was constructed by using the results of the suitability analysis from applying the suitability framework developed in the previous phases. The results from the first phase were also incorporated in the SDM not only in the selection of the security and privacy aspect, but also in the philosophical approach. The philosophical approach of the DMLBG is to develop a location-based game by increasing the development efficiency, agile development and reducing the complexity resulting from the collaboration of different departments by using paired integration and integrated testing while emphasising secure development. The process model for the DMLBG is phases and steps that are incremental and iterative. The tools and techniques associated with this SDM are research, game category scoring, storyboards, feasibility study, identifying teams, parallel game design, parallel development, paired integration, alpha and beta testing, backwards stepping, marketing campaign, game branding, support and tutorials, and user feedback. Because the DMLBG does have the four main components which are required for an SDM, the DMLBG can be classified as a complete SDM.

The conclusion for this phase is provided in Chapter 7. In the next chapter the focus will be on the fourth phase of the development of the DMLBG. In the fourth phase the DMLBG developed in phase three will be used in four different case studies consisting of indie games developers. Each of the case studies will use the DMLBG to develop a location-based game. The process will be documented and evaluated by each team. This feedback will then be analysed and used to refine and improve the DMLBG.

Chapter 6 Test, refine and improve the DMLBG

This phase, as well as phase 3 of the study, are based on the research paper: **The development of a systems development methodology for location-based games**. The paper was submitted to the journal: **Computers in Entertainment**. Currently the status of the paper is: **Under Review**.

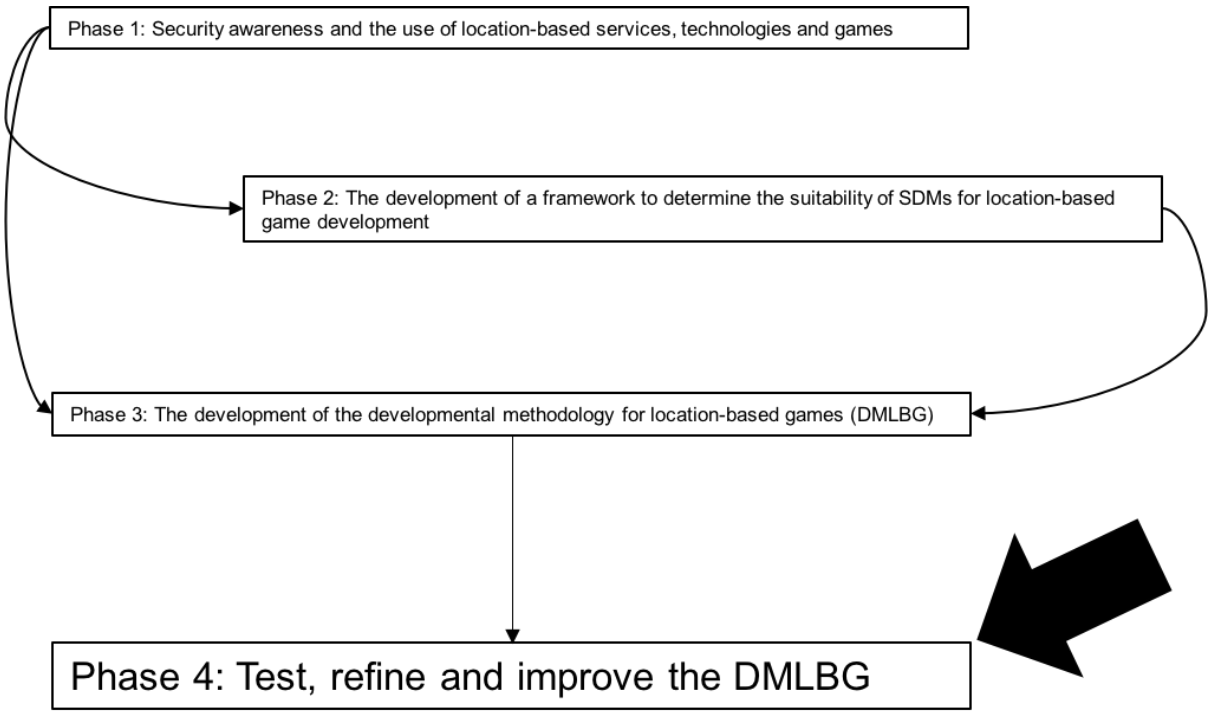


Figure 6-1: Research roadmap – phase 4

6.1. Introduction

In the last phase (Figure 6-1) of this study the focus will be on testing, refining and improving the DMLBG that was developed in the previous phase. Four groups of indie games development teams were identified to partake in the testing of the DMLBG. Each of the teams will develop a location-based game by following the DMLBG. Furthermore, each of the teams will have to document the process as the development progresses. The documentation of the teams will be analysed and based on the critique and feedback from the development teams, refinement and improvements will be done to the DMLBG.

The sub-objectives for this phase will be discussed in section 6.2 whereafter the case studies, in which the DMLBG are going to be tested, will be discussed in section 6.3. In section 6.4 the analysis of using the DMLBG will be discussed in more detail. The refined and improved DMLBG will be presented in section 6.5 with a summary following in section

6.6. A complete discussion of the case study research method that was used for this phase is given in Chapter 2.

6.2. Sub-Objectives

In this phase of the study the focus is on testing and refining the DMLBG that was developed in the previous phase. The sub-objectives identified to accomplish this are as follows:

1. Allow indie games developers to use the DMLBG to develop location-based games in order to evaluate the DMLBG.
2. Use the developers' and project managers' feedback to improve and refine the SDM.

6.3. Case Studies

6.3.1. Case study 1: Laboratory Products (location-based game: Smells)

Laboratory Products consisted of nine team members. Smells is a real-time strategy location-based game. Smells is also a multiplayer game. The players of Smells need to choose between two factions, namely The Breeze or The Flatulent. These two factions play against each other. The basic aim of Smells is to conquer as many areas on the playing map as possible. A player walking to a specific area on the map and pressing the 'smell up' button on the hand-held device does this. This will mark the area in either blue (The Breeze) or green (The Flatulent) on the map. This will indicate that the specific area belongs to that faction. It is possible for a player of one faction to capture a piece of land belonging to the other faction. The faction that possesses the most land on the map will be the leader on the scoreboard.

6.3.2. Case study 2: Street Kings (location-based game: Street Kings)

The team, Street Kings, included nine team members. Street Kings is a location-based trading game. Street Kings is also a multiplayer location-based game that allows the players to choose between two sides, namely the drug lords and the police. The area map of the game will have different merchant points where transactions can occur either between the players of the game or the merchant shop in that location. The merchant shops will move to different areas on the map. The main focus of Street Kings is dependent on the side that was chosen. The drug lords need to buy merchandise in one location and sell the merchandise at another location for a profit. The police need to find the merchant shop location and if they do they can confiscate the items that are being traded by the drug lords. The police will then receive the value of the confiscated goods. The objective is to accumulate as much wealth as possible.

6.3.3. Case study 3: Creativity (location-based game: Tagit)

Creativity consisted of nine team members. Tagit is a casual sport location-based game. Tagit supports single player and multiplayer game play. In single player mode the player is tasked to 'tag' randomly generated areas on the game map. This will be done by the player moving to these specified areas on the map and 'tagging' it on the hand-held device. In multiplayer mode there will be no random-generated areas; instead the players will have to tag each other. The game will only allow you to see players that are near you. If you are able to 'tag' another person a mini-game will appear. This will task the player to reach a specific point on the map in a limited amount of time to gain experience. The objective is to gain as much experience as possible.

6.3.4. Case study 4: Campus (location-based game: Campus)

The team of Campus consisted of nine team members. Campus is a role-playing game (RPG). Campus is also a multiplayer game. The game allows the player to choose between two races, namely Elves and Dwarves. The game play allows the players to engage in battle with the players from the rival faction. You can initiate the battle by entering the enemy player's battle zone, which is an area surrounding the enemy player. The battle zone can be seen on the map. After winning the battle, the same players cannot battle each other until a cool-down period has been reached. The victor of the battle will receive experience as well as gold. The gold can be used in the shop zones on the map to access the merchants and purchase goods that will enhance the player's character. All players will also be allowed to trade goods with each other. The game will also randomly generate treasures on the map, which the players can move towards and claim. The player who claims the treasure and can keep the treasure for a specified time will receive experience, gold and items. Players can also battle each other to obtain the treasure. There will also be a scoreboard showing the player's rank in the game.

6.4. Analyse the use of DMLBG

It was required that each of the teams documents each step of the DMLBG in detail. The teams were also required to raise any issue that they found with any of the steps. The documentation of each team was extensively analysed. Each of the steps that the teams documented was summarised and places in one of three categories, namely: whether or not the team completed the step; whether the step added value to the development process; and whether the step reproduced the same outputs as another step (a duplicate step). The analysis also included any tools and/or techniques that the teams may have used to add value to the DMLBG. This information can be seen in **Appendix 6**. This table gives the results of the analysis of each of the DMLBG's steps. The completed column indicates

whether the team completed the step (Yes), partially completed the step (Partially), did not do the step (No). An abbreviation for each of the teams was used in the completed column, namely LP (Laboratory Products), CR (Creativity), CA (Campus) and SK (Street Kings). A summary of how the step was executed is presented in the "Process Followed" column. The "Extras Added" column indicated whether any of the teams added extra tools and techniques to the DMLBG. The last column, "Keep as part of revised SDM", indicates whether the step is going to be used in the next version of the DMLBG.

6.5. Refine and improve the DMLBG

As is evident from **Appendix 6**, the DMLBG needs some refinement to support real-world applications. With the teams using the DMLBG it is clear that there were some excessive and unnecessary steps included in the DMLBH, which made the DMLBG overburdened. Nevertheless, the location-based games that the teams developed using the DMLBG were successful. To determine whether or not the games were successful, the following criteria must have been met, namely the location-based game should address all the aspects (no formal study was done for this, merely the opinion of the researchers and other indie games developers), the location-based game should have been published on the respective on-line application (app) stores, and the location-based game should have been downloadable and playable by interested people. Based on this, it would seem that the DMLBG was still able to aid and guide the teams in their development process although the DMLBG still needed to be improved.

After the feedback from teams, as well as the documentation of using the DMLBG, a refined version of the DMLBG is presented. The philosophical approach and process model of the DMLBG did not change. The reason for this is that none of the teams indicated that changes needed to be made. The major problems were encountered with the steps and the tools and techniques. The changes that were made to the method are indicated in Table 6-1. The action that was taken for each step is shown in this table. The steps in **bold** were kept as is in the method, the steps in *italic* were combined with other steps, the steps that are **bold** and *italic* were renamed and the ~~strikethrough~~ steps were removed from the method.

Table 6-1: Changes made to the method of the DMLBG

DMLBG Phases and Steps	Action taken
Phase 1: Research Phase	
1.1. Decide initial concept of game	Kept
1.2. Identify key specialists for initial phases	Kept
1.3. Concept development	
1.3.1. List game features	Kept
1.3.2. Estimate scores for game features	Kept
1.3.3. Determine game category	Kept
1.3.4. Adjust game concept	Kept
1.4. Market research	Combine into one phase.
1.5. Research accuracy of game concepts	Kept
Phase 2: Concept Phase	
2.1. Feasibility study	
2.1.1. Determine feasible solution	Kept
2.1.2. Identify every possible approach	Kept
~~2.1.3. Illustrate organisational factors~~	Removed
2.1.4. Provide playability and re-playability factors	Kept
2.1.5. Cost analysis and planning	Kept, step needs to be renamed to estimate cost.
2.2. Functionality planning	
~~2.2.1. Compile revised description and adaptability specifications~~	Removed
~~2.2.2. Factor in gameplay feedback~~	Removed
~~2.2.3. Adaptability features~~	Removed
~~2.2.3.1. Identify different states of the game~~	Removed
~~2.2.3.2. Determine different game and adaptability features for each game state~~	Removed
~~2.2.3.3. Determine adaptability features for dynamic model~~	Removed
~~2.2.3.4. Determine adaptability features for mechanic model~~	Removed

DMLBG Phases and Steps	Action taken
~~2.2.3.5. Determine adaptability feature for game settings~~	Removed
~~2.2.3.6. Determine design implications for adaptability~~	Removed
2.3. Preliminary context design	
2.3.1. Identify resources needed for the game	Kept
~~2.3.2. Identify specialists needed for the game~~	Removed
~~2.3.3. Identify the contextual information usage in the game~~	Removed
2.3.4. Decide counter-plan and action if plans or resources are not available	Combine with and identify resources needed for game
~~2.3.5. Decide how resources will be used in the game~~	Removed
2.4. Security	
2.4.1. Identify game data that is sensitive	Combine into one phase.
~~2.4.2. Identify network packets that are sensitive~~	Removed
2.4.3. Identify other security weaknesses	Kept
2.4.4. Choose valid action for weaknesses, data and network	Kept
2.5. Initial game flow design	
2.5.1 Identify major cognitive process flows within the game	Combine into one phase.
2.5.2. Develop storyboard for game flow	Kept
2.5.3. Determine game type and experience to navigate different process flows	Kept
~~2.5.4. Revise storyboard to include in-game tutorial based on previous step~~	Removed
~~2.5.5. Develop first draft of aesthetic model~~	Removed
~~2.5.6. Present set of storyboards to testers~~	Removed
~~2.5.7. Present aesthetic model to testers~~	Removed
~~2.5.8. Modify storyboards to accommodate tester input~~	Removed
Phase 3: Pre-design Phase	
3.1. Assemble team	
~~3.1.1. Identify specialists~~	Removed

DMLBG Phases and Steps	Action taken
~~3.1.2. Identify organisational departments' involvement~~	Removed
3.1.3. Identify specialists that need to work as pairs	Kept
3.2. Exploration	
3.2.1. Discuss requirements identified in new team	Kept
~~3.2.2. Discuss needs of game in new team~~	Removed
~~3.2.3. Develop functional solution~~	Removed
~~3.3. Get identified team up to date~~	Removed
3.4. Plan ahead	
3.4.1. Plan for the next phases	Kept
~~3.4.2. Integrate previous and upcoming outputs~~	Removed
Phase 4: Design Phase	
4.1. Game Identity	
4.1.1. Develop framework for game	Kept, rename to Design framework for game
4.1.1.1. Identify core programmer design	Kept
4.1.1.2. Identify graphics design	Kept
4.1.1.3. Identify art design	Kept
4.1.1.4. Identify network design	Kept
4.1.1.5. Identify sound design	Kept
4.1.1.6. Identify security design	Kept
4.1.1.7. Identify AI design	Kept
~~4.1.2. Integrate design from different specialists~~	Removed
~~4.2. Analyse game framework with entire team~~	Removed
~~4.3. Design Planning~~	Removed
~~4.3.1. Refine cost and design implications~~	Removed
~~4.3.2. Determine different platforms for deploying game~~	Removed
~~4.3.3. Compile compatibility list~~	Removed
4.4. Design	

DMLBG Phases and Steps	Action taken
4.4.1. Implement logical design according to specifications	Kept
~~4.4.2. Implement physical design according to specifications~~	Removed
Phase 5: Development Phase	
5.1. Development Planning	
5.1.1. Identify standards	Kept
~~5.1.2. Identify development environment, tools and techniques~~	Removed
5.1.3. Identify implementation plan	Kept, rename to Develop implementation plan
5.1.4. Identify integration plan	Kept
5.1.5. Identify development plan	Kept, rename to Develop development plan
~~5.1.6. Develop integration plan based on development plan~~	Removed
5.2. Development	
5.2.1. Specialists develop prototype	Kept
~~5.2.1.1. Integrate test results from previous integrated prototype testing if there are any~~	Removed
~~5.2.1.2. Develop new prototype for first iteration or develop new prototype based on the previous iteration~~	Removed
5.2.2. Paired integration	
5.2.2.1. Different team members team up to integrate developed prototypes to form one large integrated prototype	Kept
5.2.3. Implement each integrated prototype	Kept
5.2.3.1. Implement integrated prototype in test environment	Kept
5.2.3.2. Hand integrated prototype over to testers	Kept
Phase 6: Testing Phase	
6.1. Integrated testing	Kept
6.1.2. Test each implementation of integrated prototype	Kept
6.2. Alpha testing	Kept
6.3. Beta testing	Kept

DMLBG Phases and Steps	Action taken
Phase 7: Tuning Phase	
7.1. Analyse problems identified in testing	Kept
7.2 Analyse tester or closed beta players' feedback	Kept
7.3 Apply six aspects of playability and re-playability	Kept
7.3.1. Tuning based on social	Kept
7.3.2. Tuning based on completion	Kept
7.3.3. Tuning based on experience	Kept
7.3.4. Tuning based on challenging	Kept
7.3.5. Tuning based on mastery	Kept
7.3.6. Tuning based on impact	Kept
~~7.4. Re-design development plan~~	Removed
Phase 8: Pre-production Phase	
8.1. Marketing campaign (integrated in phases 1-8)	
8.1.1. Design game name	Kept
8.1.2. Design game logo	Kept
8.1.3. Design marketing campaign	Kept
8.1.4. Develop game branding	Kept
~~8.2. Finalise game branding~~	Removed
~~8.3. Finalise game marketing campaign~~	Removed
~~8.4. Finalise tuning~~	Removed
Phase 9: Release Phase	
9.1. Support	
9.1.1. Set up support for the different platforms	Kept
9.1.2. Set up support channels	Kept
9.1.3. Implement support communication channels	Kept
9.1.4. Implement support team	Kept
9.2. Pre-Release	
9.2.1. Ensure game is ready for deployment on all platforms	Kept

DMLBG Phases and Steps	Action taken
9.2.2. Ensure deployment for each platform market is understood	Kept
9.3. Deploy game	Kept
Phase 10: Monitoring Phase	
10.1. Allow players to give feedback in-game	Kept
10.2. Set up different social media channels for player feedback	Kept

The revised method and added tools and techniques for the DMLBG are illustrated in Table 6-2.

Table 6-2: Refined method of the DMLBG

DMLBG Phases and Steps	Tools and techniques
Phase 1: Research Phase	
1.1. Decide initial concept of game	
1.2. Identify key specialists for initial phases	
1.3. Concept development	
1.3.1. List game features	
1.3.2. Estimate scores for game features	Using a scoring matrix
1.3.3. Determine game category	
1.3.4. Adjust game concept	
1.4. Market research and accuracy of game concepts	Strengths, weaknesses, opportunities and threats analysis
Phase 2: Concept Phase	
2.1. Feasibility study	
2.1.1. Determine feasible solution	Weighted score matrix, Feasibility matrix
2.1.2. Identify every possible approach	
2.1.3. Provide playability and re-playability factors	
2.1.4. Estimate cost and time	COCOMO, Pert charts
2.2 Identify resources and counterplan if resources are not available	Project Triangle
2.3. Security	
2.3.1. Identify game data that is sensitive on local devices, server and	

DMLBG Phases and Steps	Tools and techniques
network	
2.3.2. Identify other security weaknesses	
2.3.3. Choose valid action for weaknesses, data and network	
2.4. Identify and develop major cognitive process flows and storyboard	Flow diagrams, screen mock-ups
Phase 3: Pre-design Phase	
3.1. Identify specialists that need to work as pairs	
3.2. Discuss requirements identified in new team	
3.3. Plan for the next phases	
Phase 4: Design Phase	
4.1. Game Identity	
4.1.1. Design framework for game	
4.1.1.1. Identify core programmer design	
4.1.1.2. Identify graphics design	
4.1.1.3. Identify art design	
4.1.1.4. Identify network design	
4.1.1.5. Identify sound design	
4.1.1.6. Identify security design	
4.1.1.7. Identify AI design	
4.2 Implement logical design according to specifications	Data and process flow diagrams
Phase 5: Development Phase	
5.1. Development Planning	
5.1.1. Identify standards	
5.1.2. Develop implementation plan	
5.1.3. Identify integration plan	
5.1.4. Develop development plan	
5.2. Development	
5.2.1. Specialists develop prototype	
5.2.2. Different team members team up to integrate developed prototypes to form one large integrated prototype	
5.2.3. Implement each integrated prototype	
5.2.3.1. Implement integrated prototype in test environment	

DMLBG Phases and Steps	Tools and techniques
5.2.3.2. Hand integrated prototype over to testers	
Phase 6: Testing Phase	
6.1. Integrated testing	
6.1.2. Test each implementation of integrated prototype	
6.2. Alpha testing	
6.3. Beta testing	
Phase 7: Tuning Phase	
7.1. Analyse problems identified in testing	
7.2 Analyse tester's or closed beta players' feedback	
7.3 Apply six aspects of playability and re-playability	
7.3.1. Tuning based on social reasons	
7.3.2. Tuning based on completion	
7.3.3. Tuning based on experience	
7.3.4. Tuning based on challenging	
7.3.5. Tuning based on mastery	
7.3.6. Tuning based on impact	
Phase 8: Pre-production Phase	
8.1. Marketing campaign (integrated in phases 1-8)	
8.1.1. Design game name	
8.1.2. Design game logo	
8.1.3. Design marketing campaign	
8.1.4. Develop game branding	
Phase 9: Release Phase	
9.1. Support	
9.1.1. Set up support for the different platforms	Support flow diagram, support tree
9.1.2. Set up support channels	
9.1.3. Implement support communication channels	
9.1.4. Implement support team	
9.2. Pre-release	
9.2.1. Ensure game is ready for deployment on all platforms	

DMLBG Phases and Steps	Tools and techniques
9.2.2. Ensure deployment for each platform market is understood	
9.3. Deploy game	
Phase 10: Monitoring Phase	
10.1. Allow players to give feedback in-game	
10.2. Set up different social media channels for player feedback	

6.6. Summary

In this phase of the development of the DMLBG, the DMLBG was tested, refined and improved. This was done by using the developed DMLBG from the previous phase in the development of four location-based games. The DMLBG was given to four indie games development groups to follow as they developed their location-based games. Each of the teams was able to successfully develop a location-based game and deploy the game on the respective on-line app stores while using the DMLBG.

The documentation, as well as the critical feedback from each of the teams were analysed. Bases on this, changes were made to the DMLBG. The philosophical approach, as well as process model were not changed, as none of the indie game development teams indicated that they encountered any issues with these elements of the DMLBG. The teams indicated that they experienced problems with the method, as well as with the tools and techniques. The method of the DMLBG was changed and extra tools and techniques were added to the revised version of the DMLBG. The revised version of the DMLBG is shown in Table 6-2. It seems that despite the shortcomings of the DMLBG that the indie games developers encountered, the DMLBG still aided them in developing a successful location-based game.

The conclusion of the study is provided in the next chapter.

Chapter 7 Conclusion

The main aim of this study was to develop and test a specialised SDM that is suitable to aid in the development process of location-based games. To be able to achieve this objective, a literature study was done to determine whether or not there is an SDM for location-based games. To the best of the researcher's knowledge there is no specialised SDM suitable to aid in the development of location-based games. By analysing the relevant literature, different SDMs that could potentially be used for the development of location-based games were identified, evaluated and incorporated in the DMLBG. The development of the DMLBG was a process with different phases that were followed. Each of the phases added sub-objectives to aid in finally developing the DMLBG.

The aims and objectives for the entire study will be provided in section 7.1. The results of the study will be provided in section 7.2, whereafter the limitations of the study, future work and the major contributions for this study will be highlighted in sections 7.3, 7.4 and 7.5 respectively.

7.1. Aims and Objectives

The primary aim of this study was to develop and test an SDM that is better suited to aid in the development of location-based games.

To achieve the primary aim, the following sub-objectives needed to be achieved:

1. Determine the effect of using mobile location-based technologies and mobile location-based services on security awareness.
2. Determine the effect of playing location-based games on security awareness.
3. Define unique aspects that need to be addressed in the development process of location-based game development to determine the requirements for a new SDM.
4. Test the aspects in a survey to gather information, from the gaming industry, to determine how important each aspect is and whether or not the study has neglected to incorporate any aspects.
5. Develop a framework based on the feedback from the industry that can be used to analyse SDMs to determine their suitability to aid in the development of location-based games
6. Demonstrate the use of the framework by analysing a few selected SDMs to determine their suitability for the development of location-based games.

7. Develop an SDM that can aid in the development of location-based games; the development will be based on the analysis that will be done in the previous sub-objective.
8. Allow independent (indie) games developers to use the SDM to develop location-based games in order to evaluate the SDM.
9. Use the developers' and project managers' feedback to improve and refine the SDM.

Each of these research sub-objectives was addressed and presented in the different phases of this study. The mapping of phases and sub-objectives are illustrated in Table 7-1.

Table 7-1: Phases addressing sub-objectives

Sub-objectives	Phases addressing the Sub-objectives
1 and 2	Chapter 3 (Phase 1: Security awareness and the use of location-based services, technologies and games)
3, 4, 5 and 6	Chapter 4 (Phase 2: The development of a framework to determine the suitability of systems development methodologies for location-based game development)
7	Chapter 5 (Phase 3: The development of the DMLBG, a systems development methodology for location-based games)
8 and 9	Chapter 6 (Phase 4: Test and refine the DMLBG)

7.2. Results

The results of this study will be grouped together and presented as each of the phases of this study was executed.

7.2.1. Phase 1: Security awareness and the use of location-based services, technologies and games

In this phase of the development of the DMLBG the aim was to determine whether there is a difference between computer science students who use, and computer science students who do not use mobile location-based technologies, services and games regarding their security awareness of location-based data. Two sub-objectives were set to determine whether this was true or not. The first was to determine the effect of using mobile location-based technology and mobile location-based services on security awareness. The second was to determine the effect of playing location-based games on security awareness. A questionnaire was used to gather data to achieve these sub-objectives. Subsequently, statistical methods were utilised to determine whether there is a difference between the computer science students who use and computer science students who do not use mobile location-based technologies, services and games regarding their awareness of security.

To achieve the first sub-objective, independent t-test results between mobile location-based technology use and the security awareness variables were analysed. From these analyses it was clear that the computer science students who use some of these technologies monitored location-based applications and games more than non-users and were also more cautious of security implications. On average, there was a small difference between users and non-users. However, in the case of iPhone, non-users were more cautious in regards to security awareness than users. The possible cause for this can be that iOS (the iPhone operating system) forces the user to choose the location setting for every application or game.

To achieve the second sub-objective, independent t-test results between location-based games and the security awareness variables were analysed. This analysis indicated that there was a small difference between computer science students who played games and those who did not. The computer science students who did play location-based games did monitor location-based applications and games more than those who did not and they also had an increased cautiousness for security implications

The study did achieve both sub-objectives although with a small difference between the groups. This indicates that computer science students who use and play some (but not all) location-based technologies, services, software and games are more aware of security with regard to location-based data. However, it was very surprising that the values for the security awareness variables monitor location-based applications and monitor location-based games were very low. This was investigated further and led to an important finding.

In this phase it was found that the computer science students, although indicating that they are cautious of security implications, do not take precautions to enforce security measures. This is evident from the analysis of the dependent t-tests for the security awareness variables. In this analysis there was a very large difference in monitoring location-based applications and games (by turning off their location capabilities) and the cautiousness of security implications. The mean for the cautiousness of security was 3.18 and the means for monitoring location-based games and applications were 0.02 and 0.97 respectively.

This poses a very high security threat for the computer science students. It increased the risk that the computer science students could fall victim to many of the harmful consequences of their location data being stolen. Some of the harm that could befall the computer science students is that the attacker inflicts physical harm on the computer science student whose location-based data is compromised; the location-based data can be sold to third-party advertising agencies; the attacker can stalk the computer science student; identity theft can occur; the attacker asserts himself/herself in the computer science student's life; and the attacker can cause financial damage to the computer science student. This shows that this is a major concern that needs to be addressed to avoid harm from befalling the computer science students.

A possible solution is that security awareness and the prevention of location-based data being stolen needs to be taught to the computer science students from their first year. Security awareness campaigns can also be launched at schools to inform the pupils of the harm caused by stolen location-based data as well as how to prevent location-based data from being stolen. These are merely some suggestions and future studies will need to be carried out. The results of this phase were used in the following phases to ensure that security and privacy was included as an aspect that was used to develop the suitability framework. This allowed the framework to emphasise the importance of secure development of location-based games.

7.2.2. Phase 2: The development of a framework to determine the suitability of SDMs for location-based game development

In this phase the development of a framework that could evaluate SDMs' suitability for developing location-based games was proposed. The development of this framework is important due to the fact that to the researcher's knowledge there are no frameworks, mechanisms, tools or techniques that can be used to do this evaluation. Secondly, this is also important because to the researcher's knowledge there are no SDMs that are specifically designed for the development of location-based games. To be able to develop this framework, a set of aspects needed for the development process of location-based

games, needed to be identified. These aspects determine the successful development of location-based games. The aspects were identified from the literature and formed the evaluation criteria for the suitability framework. The suitability framework was used to evaluate the following SDMs, namely SDLC, Scrum, MASAM, Mobile-D, RAD with DSDM Atern, MDA, Playability and Re-playability and Player-centred game design. These SDMs are usually used in mobile development, mobile game development or game development. The aspects were ranked to determine their importance for the development of location-based games by using a survey. The results of the survey were used to develop the framework that is shown in **Appendix 4**. Each of the SDMs was analysed and scored by independent developers and the researcher with regard to each SDM's incorporation of each aspect needed in the development process of location-based games.

The results of the framework indicated that none of the SDMs chosen was 100% suitable for the development of location-based games. Playability and Re-playability scored the highest with a suitability of 63.14% and Mobile-D was the lowest with a suitability of 31.60%. This clearly indicates that there is a need for more SDMs that are more specific for the development of location-based games. None of the aspects were addressed a 100% by any of the SDMs evaluated in this framework. The highest scoring aspect, value to the player, did score 87.97% across all the SDMs in this framework with the lowest scoring aspect, security and privacy, only scoring 20.47% across all the SDMs. This is problematic since it is an important aspect needed in the development process of location-based games as described in the previous phase. If neither the developers nor the SDMs emphasise secure development, the players of location-based games are left in harm's way as they do not take precautions in regards to location-based technologies, services and games. It is critical that the SDM ensures that the games developers incorporate security and privacy in the development of location-based games.

The sub-objectives of this phase were met by the following: defining the aspects required for location-based game development; using these aspects in a survey to gauge their importance with regard to the development of a location-based game; developing a framework based on the results of the survey and demonstrating the use of the framework by applying it to the chosen SDMs. In addition to the sub-objectives, the study also contributed by indicating the inadequate suitability of the chosen SDMs for the aspects needed in the development process of location-based games and also the inadequate ability to address these aspects by all the SDMs. The results of the suitability analysis were used in the next phase to identify a list of steps and techniques that can be considered for inclusion

in the DMLBG. This allowed the DMLBG to be more suitable to aid in the development of location-based games.

7.2.3. Phase 3: The development of the Developmental Methodology for Location-Based Games (DMLBG)

In this phase the development of an SDM for location-based games was proposed. As far as the researcher is aware, there is no tailor-made SDM specifically for the development of location-based games. The development of the SDM was done by first analysing current SDMs with the suitability framework developed in the previous phase. The identified SDMs were: SDLC, Scrum, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Playability and Re-playability and Player-centred game design.

The Developmental Methodology for Location-Based Games (DMLBG) was developed by using the steps and techniques that were identified from the results of the suitability framework in the previous phase. The results from the first phase were also incorporated in the SDM not only in the selection of the security and privacy aspect, but also in the philosophical approach. The philosophical approach of the DMLBG is to develop a location-based game by increasing the development efficiency, agile development and reducing the complexity resulting from the collaboration of different departments by using paired integration and integrated testing while emphasising secure development. The process model for the DMLBG is phases and steps that are incremental and iterative. The tools and techniques associated with this SDM are: research, game category scoring, storyboards, feasibility study, identifying teams, parallel game design, parallel development, paired integration, alpha and beta testing, backwards stepping, marketing campaign, game branding, support and tutorials, user feedback. Due to the fact that the DMLBG has the four main components which are required for an SDM, the DMLBG can be classified as a complete SDM.

7.2.4. Phase 4: Test, refine and improve the DMLBG

In this phase the focus was on testing, refining and improving the DMLBG developed in the previous phase.

The DMLBG was given to four indie game development teams to use. They named themselves Laboratory Products, Creativity, Campus and Street Kings. The teams were instructed to develop a location-based game by strictly following the DMLBG. The teams were also tasked to document the entire process, as well as to give feedback on each step of the DMLBG. Each indie team was able to successfully develop a location-based game and to deploy the game on the respective on-line app stores.

The documentation, as well as the critical feedback from each team were analysed. This was used to determine whether or not a step in the DMLBG was needed. This analysis was used to revise the DMLBG to produce a new version of the DMLBG. The philosophical approach, as well as process model were not changed, as none of the indie teams indicated that they encountered any issues with these elements of the DMLBG. The teams indicated that there were inefficiencies in the DMLBG with regard to the method, as well as the tools and techniques (for a full list of inefficiencies, refer to **Table 6-1** in **Chapter 6**). The method of the DMLBG was changed and extra tools and techniques were added to the DMLBG's new revision. It seems that despite the shortcomings of the DMLBG the indie games developers found that the DMLBG still aided them in developing a successful location-based game. The revised method as well as the tools and techniques of the DMLBG can be seen in Table 7-2.

Table 7-2: Refined method of the DMLBG

DMLBG Phases and Steps	Tools and techniques
Phase 1: Research Phase	
1.1. Decide initial concept of game	
1.2. Identify key specialists for initial phases	
1.3. Concept development	
1.3.1. List game features	
1.3.2. Estimate scores for game features	Using a scoring matrix
1.3.3. Determine game category	
1.3.4. Adjust game concept	
1.4. Market research and accuracy of game concepts	Strengths, weaknesses, opportunities and threats analysis
Phase 2: Concept Phase	
2.1. Feasibility study	
2.1.1. Determine feasible solution	Weighted score matrix, Feasibility matrix
2.1.2. Identify every possible approach	
2.1.3. Provide playability and re-playability factors	
2.1.4. Estimate cost and time	COCOMO, Pert charts
2.2 Identify resources and counterplan if resources are not available	Project Triangle
2.3. Security	
2.3.1. Identify game data that is sensitive on local devices, server and network	

DMLBG Phases and Steps	Tools and techniques
2.3.2. Identify other security weaknesses	
2.3.3. Choose valid action for weaknesses, data and network	
2.4. Identify and develop major cognitive process flows and storyboard	Flow diagrams, screen mock-ups
Phase 3: Pre-design Phase	
3.1. Identify specialists that need to work as pairs	
3.2. Discuss requirements identified in new team	
3.3. Plan for the next phases	
Phase 4: Design Phase	
4.1. Game Identity	
4.1.1. Design framework for game	
4.1.1.1. Identify core programmer design	
4.1.1.2. Identify graphics design	
4.1.1.3. Identify art design	
4.1.1.4. Identify network design	
4.1.1.5. Identify sound design	
4.1.1.6. Identify security design	
4.1.1.7. Identify AI design	
4.2 Implement logical design according to specifications	Data and process flow diagrams
Phase 5: Development Phase	
5.1. Development Planning	
5.1.1. Identify standards	
5.1.2. Develop implementation plan	
5.1.3. Identify integration plan	
5.1.4. Develop development plan	
5.2. Development	
5.2.1. Specialists develop prototype	
5.2.2. Different team members team up to integrate developed prototypes to form one large integrated prototype	
5.2.3. Implement each integrated prototype	
5.2.3.1. Implement integrated prototype in test environment	
5.2.3.2. Hand integrated prototype over to testers	

DMLBG Phases and Steps	Tools and techniques
Phase 6: Testing Phase	
6.1. Integrated testing	
6.1.2. Test each implementation of integrated prototype	
6.2. Alpha testing	
6.3. Beta testing	
Phase 7: Tuning Phase	
7.1. Analyse problems identified in testing	
7.2 Analyse tester's or closed beta players' feedback	
7.3 Apply six aspects of playability and re-playability	
7.3.1. Tuning based on social reasons	
7.3.2. Tuning based on completion	
7.3.3. Tuning based on experience	
7.3.4. Tuning based on challenging	
7.3.5. Tuning based on mastery	
7.3.6. Tuning based on impact	
Phase 8: Pre-production Phase	
8.1. Marketing campaign (integrated in phases 1-8)	
8.1.1. Design game name	
8.1.2. Design game logo	
8.1.3. Design marketing campaign	
8.1.4. Develop game branding	
Phase 9: Release Phase	
9.1. Support	
9.1.1. Set up support for the different platforms	Support flow diagram, support tree
9.1.2. Set up support channels	
9.1.3. Implement support communication channels	
9.1.4. Implement support team	
9.2. Pre-release	
9.2.1. Ensure game is ready for deployment on all platforms	
9.2.2. Ensure deployment for each platform market is understood	

DMLBG Phases and Steps	Tools and techniques
9.3. Deploy game	
Phase 10: Monitoring Phase	
10.1. Allow players to give feedback in-game	
10.2. Set up different social media channels for player feedback	

7.3. Limitations

Although all the sub-objectives of this study were achieved, there are still some limitations that need to be addressed and which can be viewed as future work.

The fact that only computer science students were included in the first part of this study is a limitation. The participants of the security awareness survey could potentially include more students from different areas of study. Furthermore, only students from one university were asked to complete the survey. This could be expanded to include students from different universities.

In testing the suitability framework only four independent developer teams were asked to use the suitability framework. This could be addressed by including more developers to use the suitability framework to gather more information on the suitability of SDMs for aiding in the development of location-based games. Furthermore, the suitability framework was used to only analysed eight selected SDMs in this study. To gather more information on how different SDMs address the development process for location-based games development, additional SDMs could be evaluated.

The revised DMLBG was not tested in a practical setting. A new set of indie games developers could follow the DMLBG to determine if the adjustments made improved the SDM. This could also include new adjustments to improve the SDM even more. In addition, the location-based games were only analysed by the researcher to determine if the games did address all the aspects. By allowing mobile games developers to analyse the location-based games, it could be determined to what extent the aspects aided in the location-based game development process.

7.4. Future work

There are a number of additional research projects that could be built on this study, not including the limitations mentioned above.

The participants of the security awareness survey could include more than just students to determine the security awareness of a boarder audience. In addition, it is suspected that students are not aware that they use location-based data and this could be investigated in a further study, as well as the reason why the use of some location-based technologies, services, software and games increases the security awareness whereas the use of others does not. It is also clear that there is a lack of security awareness with regard to location-based technologies, services and games, which needs to be addressed by researching ways to improve the security awareness of students.

A further possibility could be to get mobile games developers to use the suitability framework and to analyse the suitability of the DMLBG for location-based game development to determine to what degree the DMLBG is suitable for location-based games development.

7.5. Contributions

This study had nine different sub-objectives that had to be achieved. All nine sub-objectives were successfully achieved. Furthermore, all these sub-objectives contributed to the field of computer science and information systems. Although the sub-objectives may be regarded as minor contributions to these fields, by grouping them together three major contributions can be identified. Each of the major contributions is also presented as journal papers that have been submitted for review as mentioned at the beginning of each phase. As mentioned, each has been submitted to a journal and feedback is awaited.

7.5.1. Precautions to enforce security measures not taken

In phase 1 it was discovered that computer science students, although indicating that they are cautious of security implications, do not take precautions to enforce security measures. As mentioned, this poses a very high security threat for the computer science students who make use of location-based technologies, services and games.

This is of great interest, as well as a major contribution to the field of computer science and information systems. This information is relevant for developers of location-based technologies, services and games. This finding can allow the developers to compensate for this high security threat by ensuring the development of secure location-based technologies, services and games. This information is also relevant for people in education and it can empower them to be able to inform students of the harm that could befall them if their location-based data was compromised. This information could also aid people in education to launch security awareness campaigns in order to be able to teach the students how to prevent the security infringement of their location-based data. An example of where the security awareness could have prevented players from getting into harm's way is the newly

released Pokémon GO game. In the week that Pokémon GO was released, a surge of security issues were reported, some of which include players who had been robbed as the robbers could guess players' locations based on where large number of the Pokémons could be found, a player was caught in an alleged drug deal, players who did not respect personal property and trespassed in order to be able to capture Pokémons, stepping in front of traffic, the game accesses all personal Google account details if the player does not switch this function off and players driving while playing the game and endangering other drivers on the road (Akolawala, 2016; Arora, 2016; Lee, 2016; Lindh, 2016; Matyszczyk, 2016; Reuters, 2016; Schwartz, 2016; Summers, 2016). If the necessary information was given to the players, the security awareness of the players could have been higher, which in turn could have prevented some of the incidents mentioned.

7.5.2. Suitability framework

In phase 2 a suitability framework was developed. This framework allows the user to evaluate the suitability of an SDM in aiding in the development of a location-based game.

This major contribution to the field of computer science and information systems will empower games developers and managers of location-based game projects to analyse the suitability of SDMs in respect of aiding in the development of location-based games. This will allow the games developers or managers to choose an SDM upfront that can be more suitable for the specific project and will allow for a better development process for the location-based game.

7.5.3. The Developmental Methodology for Location-Based Games (DMLBG)

In phase 3, an SDM was developed for location-based game development and in phase 4 it was tested, refined and improved in order to be able to present the DMLBG.

The DMLBG is the first SDM of its kind. The SDM was specifically developed for location-based game development. The major contribution in this field of computer science and information systems is that location-based games developers and managers would have an SDM that they could specifically use for their location-based game project. This could help them in the development process in the same way that SDMs have helped in other non-game development projects. This DMLBG can also allow companies other than Nintendo to develop location-based games, such as Pokémon GO. This SDM can specifically aid game development companies that have less experience in developing location-based games, as the DMLBG was specifically developed to aid in the development of location-based games.

The DMLBG could also be used by more experienced game development companies to improve their location-based development process where needed.

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Appendix 1 Security awareness survey

Section	Question Number	Question	Options	Frequency
1	1	Gender	Male, Female	
1	2	Age	Under 18, 18-21, 22-25, 26-30, 31-40, 41-50, Over 50	
1	3	Home language	Afrikaans, English, Sotho, Tswana, Xhosa, Zulu	
1	4	Ethnicity	Black African, Colored, Indian or Asian, White	
1	5	What is the HIGHEST qualification you COMPLETED?	None, Senior certificate (Matric), Certificate or diploma, University or Technicon degree, Honors degree, Master's degree, PhD	
1	6	What is the HIGHEST qualification you COMPLETED in Information Technology or Computer Science?	None, Senior certificate (Matric), Certificate or diploma, University or Technicon degree, Honors degree, Master's degree, PhD	
1	7	Are you CURRENTLY studying? Choose highest level if more than one.	None, School, Diploma, 1st year degree, 2nd year degree, 3rd year degree, Honors degree (or 4th year), Master's degree, PhD	
1	8	If you are CURRENTLY studying, which of the following is applicable to your field of study?	School with Computer Science as subject, School without Computer Science as subject, Diploma in IT or Computer Science, Diploma in other field of study, University undergraduate degree with focus on Computer Science or IT, University undergraduate degree in other field of study, Honors degree with focus on Computer Science or IT, Honors degree in other field of study, Master's degree with focus on Computer Science or IT, Master's degree in other field of study, PhD degree with focus on Computer Science or IT, PhD degree in other field of study	
1	9	In which of the following fields do you have WORK EXPERIENCE? Choose all applicable options and also indicate the number of YEARS.	Academic / Research, Accounts, Advertising, Banking / Finance And Investment, Engineering, Environmental / Horticulture / Agriculture, Freight / Shipping / Transport / Import / Export, Government / Municipal, Health & Fitness, Hospitality / Tourism, Human Resources, Information Technology, Insurance, Legal, Management Consulting, Manufacturing, Pharmaceutical / Medical / Healthcare / Hygiene, PR / Communications / Journalism / Media And Promotions, Production, Property, Publishing, Retail, Safety And Security, Sales And Marketing, Technical support, Telecommunications	
1	10	How many HOURS on average do you play MOBILE (cell phone and tablet) games in a WEEK?	Under 1 hour, 1-5 hours, 6-10 hours, 11-15 hours, more than 15 hours	
1	11	How many HOURS on average do you play CONSOLE (PlayStation, Xbox, Wii) games in a WEEK?	Under 1 hour, 1-5 hours, 6-10 hours, 11-15 hours, more than 15 hours	

Section	Question Number	Question	Options	Frequency
1	12	How many HOURS on average do you play COMPUTER games in a WEEK	Under 1 hour, 1-5 hours, 6-10 hours, 11-15 hours, more than 15 hours	
1	13	What PERSENTAGE of your FREE TIME do you spend playing games on average?	0 - 25 %, 26 - 50 %, 51 - 75 %, 76 - 100 %	
1	14	How would you classify yourself?	Non-gamer, Casual gamer, Avid gamer, Extreme gamer, Pro gamer	
2	1	Which of the following TECHNOLOGIES do you use and how often? Choose all that apply.	GPS, Cell phone, Smartphone (Android), Smartphone (iPhone), Smartphone (Windows), Tablet (Android), Tablet (iPad), Tablet (Windows), PC or notebook (Windows), PC or notebook (Mac), PC or notebook (Linux), Xbox, Xbox Kinect, PlayStation 2 or 3, PlayStation Move, Wii, PSP	Never, Rarely, Seldom, Often, Always
2	2	Which of the following SERVICES do you use and how often?	SMS, MMS, BBM, iMessage, email	Never, Rarely, Seldom, Often, Always
2	3	Which of the following INSTANT MESSANGERS and SOCIAL SERVICES do you use and how often?	WhatsApp, Google talk, ICQ, Mxit, Skype, Windows live Messenger, Twitter, Facebook, LinkedIn	Never, Rarely, Seldom, Often, Always
2	4	Which of the following CLOUD SERVICES do you use and how often?	Amazon Cloud Drive, Apple iCloud, Dropbox, Google Play (Drive / Docs), Microsoft SkyDrive, SugarSync, Ubuntu One, Allshare Samsung	Never, Rarely, Seldom, Often, Always
2	5	Which of the following GAMING SERVICES do you use and how often?	Battle.net, Nintendo (Wii) network, Origin, PSN (PlayStation Network), Steam, Windows live, Xbox live	Never, Rarely, Seldom, Often, Always
2	6	Where and how often do you use the INTERNET?	Home, Work, School (or university), Mobile (Cell phone), Mobile (Wi-Fi Hotspot)	Never, Rarely, Seldom, Often, Always
2	7	Do you play computer games (Windows / Mac / Linux)?	Y, N	
2	7.1	What type of OFFLINE computer games (not with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always
2	7.2	Please provide the titles of the OFFLINE computer games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	
2	7.3	What type of ONLINE computer games (with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always

Section	Question Number	Question	Options	Frequency
2	7.4	Please provide the titles of the ONLINE computer games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	
2	7.5	How much do you spend on buying computer games on disc IN A STORE per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	7.6	How much do you spend on buying computer games on disc ONLINE (e.g. Kalahari) per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	7.7	How much do you spend on buying DOWNLOADABLE (e.g. steam) computer games per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	7.8	How much do you spend on DLC (Downloadable content - additional content or resources) for computer games through online purchases per YEAR? Please include all in-game online purchases as well as subscription fees for computer games.	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	7.9	Choose all applicable options regarding computer game purchases. Skip question if none apply.	I buy special editions or collector editions of computer games, I preorder computer games	Never, Rarely, Seldom, Often, Always
2	8	Do you play console games (PlayStation, Xbox, Wii, PSP, DS)?	Y, N	
2	8.1	What type of OFFLINE console games (not with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always
2	8.2	Please provide the titles of the OFFLINE console games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	
2	8.3	What type of ONLINE console games (with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always

Section	Question Number	Question	Options	Frequency
2	8.4	Please provide the titles of the ONLINE console games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	
2	8.5	How much do you spend on buying console games on disc IN A STORE per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	8.6	How much do you spend on buying console games on disc ONLINE (e.g. Kalahari) per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	8.7	How much do you spend on buying DOWNLOADABLE (e.g. PlayStation Network, XBOX Live) console games per YEAR?	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	8.8	How much do you spend on DLC (Downloadable content - additional content or resources) for console games through online purchases per YEAR? Please include all in-game online purchases as well as subscription fees for console games.	R0-R500, R501-R1000, R1001-R1500, R1501-R2000, More than R2000	
2	8.9	Choose all applicable options regarding console game purchases. Skip question if none apply.	I buy special editions or collector editions of console games, I preorder console games	Never, Rarely, Seldom, Often, Always
2	9	Do you play mobile games (Cell phone or Tablet)?	Y, N	
2	9.1	What type of OFFLINE mobile games (not with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always
2	9.2	Please provide the titles of the OFFLINE mobile games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), Simulation, Strategy, Board games, Educational games	
2	9.3	What type of ONLINE mobile games (with or against other internet users) do you play and how often?	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	Never, Rarely, Seldom, Often, Always

Section	Question Number	Question	Options	Frequency
2	9.4	Please provide the titles of the ONLINE mobile games you play most often.	Action / Adventure, Shooter, RPG (role-playing game), MMORPG (massive multi-player online role-playing game), Simulation, Strategy, Board games, Educational games	
2	9.5	How much do you spend on buying DOWNLOADABLE (e.g. Apple app store, Google play) mobile games per YEAR?	R0-R250, R251-R500, R501-R750, R751-R1000, More than R1000	
2	9.6	How much do you spend on DLC (Downloadable content - additional content or resources) for mobile games through online purchases per YEAR? Please include all in-game online purchases as well as subscription fees for mobile games.	R0-R250, R251-R500, R501-R750, R751-R1000, More than R1000	
2	9.7	Do you buy special editions or collector editions of mobile games?	Never, Rarely, Seldom, Often, Always	
3	1	List the most used apps on your mobile device. (You may skip this question of you do not use apps on a mobile device)		
3	2	List the most used games on your mobile device. (You may skip this question if you do not play games on your mobile device)		
3	3	Do you use APPS OR GAMES that are able to monitor your LOCATION?	Y, N, I don't know	
3	3.1	Regarding Apps or Games that monitor your locations, please choose Apps, Games or both and indicate how often.	Apps, Games	Never, Rarely, Seldom, Often, Always
3	3.2	List the most used apps that monitor your location.		
3	3.3	List the most used games that monitor your location.		
3	4	Do you manage the use of your location on your device by switching it on or off?	Y, N, I don't know	

Section	Question Number	Question	Options	Frequency
3	5	Do you read reviews on security and GPS use before purchasing?	Y, N, I don't know	
3	6	Do you read the terms and conditions before installing software like applications or games?	Y, N	
3	7	What are the reasons why you do (or do not) read the terms and conditions?		
3	8	What technology or methods, that you know of, can be used to monitor your location when using computers, gaming consoles or mobile devices?		
3	9	My location data is sensitive and should be kept private at all cost. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
3	10	It will be very harmful to me if my location data is compromised. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
3	11	Give examples of the damage you would expect if your location data is compromised.		
3	12	It is important that people are aware of the SECURITY IMPLICATIONS regarding location data. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
4	1	Are you aware of any legislation regarding digital privacy?	Y, N	
4	2	Are you aware of any legislation regarding the use of location data?	Y, N	
4	3	It is important that there is specialized legislation regarding digital privacy. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
4	4	Explain your answer on the importance of specialized legislation regarding digital		

Section	Question Number	Question	Options	Frequency
		privacy.		
4	5	It is important that there is specialized legislation regarding the use of location data. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
4	6	Explain your answer on the importance of specialized legislation regarding the use of location data.		
4	7	In your opinion, what would the best way be to implement legislation regarding privacy or location data?		
4	8	It is important that people are aware of LEGISLATION regarding digital privacy and location data. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	
4	9	Properties of applications or games that influence digital privacy should be separately listed from the normal terms and conditions. How do you rate this statement?	Strongly agree, Agree, Neutral, Disagree, Strongly disagree	

Appendix 2 Full list of results for security awareness survey

GPS		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	113	0.55	1.21	0.20	0.16
	User	130	0.76	1.33	0.19	
Frequency of monitoring location-based games	Non-User	113	0.07	0.44	0.52	0.07
	User	130	0.12	0.62	0.51	
Cautiousness of security implications	Non-User	113	3.03	0.83	0.00	0.35
	User	130	3.32	0.57	0.00	
Cell Phone						
Frequency of monitoring location-based application	Non-User	99	0.74	1.32	0.45	0.10
	User	144	0.61	1.25	0.46	
Frequency of monitoring location-based games	Non-User	99	0.11	0.59	0.70	0.05
	User	144	0.08	0.51	0.70	
Cautiousness of security implications	Non-User	99	3.05	0.71	0.02	0.30
	User	144	3.27	0.70	0.02	
Android Phone						
Frequency of monitoring location-based application	Non-User	143	0.67	1.33	0.90	0.02
	User	100	0.65	1.20	0.90	
Frequency of monitoring location-based games	Non-User	143	0.04	0.31	0.07	0.17
	User	100	0.17	0.75	0.11	
Cautiousness of security implications	Non-User	143	3.18	0.76	0.89	0.02
	User	100	3.19	0.64	0.89	
iPhone						
Frequency of monitoring location-based application	Non-User	217	0.56	1.15	0.00	0.53
	User	26	1.54	1.86	0.01	
Frequency of monitoring location-based games	Non-User	217	0.08	0.50	0.33	0.14
	User	26	0.19	0.80	0.50	
Cautiousness of security implications	Non-User	217	3.22	0.65	0.02	0.33
	User	26	2.87	1.07	0.12	
Android Tablet						
Frequency of monitoring location-based application	Non-User	213	0.64	1.27	0.53	0.12
	User	30	0.80	1.35	0.55	
Frequency of monitoring location-based games	Non-User	213	0.09	0.51	0.68	0.06
	User	30	0.13	0.73	0.75	
Cautiousness of security implications	Non-User	213	3.19	0.69	0.69	0.06
	User	30	3.13	0.86	0.74	
iPad						
Frequency of monitoring location-based application	Non-User	193	0.63	1.21	0.47	0.10
	User	50	0.78	1.52	0.53	
Frequency of monitoring location-based games	Non-User	193	0.06	0.40	0.03	0.20
	User	50	0.24	0.89	0.16	
Cautiousness of security implications	Non-User	193	3.20	0.73	0.54	0.10
	User	50	3.13	0.66	0.52	
Windows Desktop						
Frequency of monitoring location-based application	Non-User	40	0.70	1.36	0.84	0.03
	User	203	0.66	1.26	0.85	
Frequency of monitoring location-based games	Non-User	40	0.00	0.00	0.23	0.19
	User	203	0.11	0.59	0.01	
Cautiousness of security implications	Non-User	40	3.13	0.74	0.63	0.08
	User	203	3.19	0.71	0.65	

Xbox						
Frequency of monitoring location-based application	Non-User	196	0.60	1.22	0.10	0.23
	User	47	0.94	1.47	0.15	
Frequency of monitoring location-based games	Non-User	196	0.08	0.49	0.45	0.09
	User	47	0.15	0.72	0.55	
Cautiousness of security implications	Non-User	196	3.19	0.73	0.78	0.04
	User	47	3.16	0.64	0.76	
PlayStation 2 and 3						
Frequency of monitoring location-based application	Non-User	184	0.69	1.29	0.55	0.09
	User	59	0.58	1.25	0.55	
Frequency of monitoring location-based games	Non-User	184	0.09	0.50	0.70	0.05
	User	59	0.12	0.65	0.73	
Cautiousness of security implications	Non-User	184	3.17	0.70	0.64	0.07
	User	59	3.22	0.76	0.66	

SMS		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	43	0.58	1.24	0.65	0.08
	User	200	0.68	1.29	0.64	
Frequency of monitoring location-based games	Non-User	43	0.12	0.54	0.77	0.05
	User	200	0.09	0.54	0.78	
Cautiousness of security implications	Non-User	43	3.02	0.91	0.09	0.22
	User	200	3.22	0.66	0.17	
MMS						
Frequency of monitoring location-based application	Non-User	203	0.60	1.22	0.09	0.25
	User	40	0.98	1.51	0.15	
Frequency of monitoring location-based games	Non-User	203	0.08	0.48	0.31	0.12
	User	40	0.18	0.78	0.46	
Cautiousness of security implications	Non-User	203	3.17	0.74	0.42	0.14
	User	40	3.27	0.59	0.35	
BBM						
Frequency of monitoring location-based application	Non-User	117	0.66	1.25	0.96	0.01
	User	126	0.67	1.31	0.96	
Frequency of monitoring location-based games	Non-User	117	0.14	0.63	0.24	0.13
	User	126	0.06	0.44	0.25	
Cautiousness of security implications	Non-User	117	3.19	0.59	0.95	0.01
	User	126	3.18	0.81	0.95	
iMessage						
Frequency of monitoring location-based application	Non-User	205	0.59	1.20	0.04	0.29
	User	38	1.05	1.61	0.10	
Frequency of monitoring location-based games	Non-User	205	0.07	0.47	0.15	0.17
	User	38	0.21	0.81	0.32	
Cautiousness of security implications	Non-User	205	3.18	0.74	0.99	0.00
	User	38	3.18	0.55	0.98	
e-mail						
Frequency of monitoring location-based application	Non-User	85	0.35	0.98	0.01	0.34
	User	158	0.83	1.38	0.00	
Frequency of monitoring location-based games	Non-User	85	0.06	0.39	0.45	0.09
	User	158	0.11	0.61	0.39	
Cautiousness of security implications	Non-User	85	3.06	0.91	0.06	0.20
	User	158	3.25	0.57	0.09	

WhatsApp						
Frequency of monitoring location-based application	Non-User	20	0.15	0.67	0.06	0.43
	User	223	0.71	1.31	0.00	
Frequency of monitoring location-based games	Non-User	20	0.00	0.00	0.42	0.18
	User	223	0.10	0.56	0.01	
Cautiousness of security implications	Non-User	20	3.07	0.87	0.45	0.15
	User	223	3.19	0.70	0.54	

Internet Home		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	44	0.59	1.24	0.68	0.07
	User	199	0.68	1.29	0.68	
Frequency of monitoring location-based games	Non-User	44	0.00	0.00	0.20	0.19
	User	199	0.12	0.60	0.01	
Cautiousness of security implications	Non-User	44	3.08	0.87	0.31	0.14
	User	199	3.20	0.67	0.39	
Internet Work						
Frequency of monitoring location-based application	Non-User	214	0.61	1.22	0.10	0.27
	User	29	1.03	1.59	0.18	
Frequency of monitoring location-based games	Non-User	214	0.09	0.51	0.65	0.07
	User	29	0.14	0.74	0.73	
Cautiousness of security implications	Non-User	214	3.16	0.73	0.26	0.22
	User	29	3.32	0.55	0.17	
Internet University						
Frequency of monitoring location-based application	Non-User	28	0.00	0.00	0.00	0.56
	User	215	0.75	1.33	0.00	
Frequency of monitoring location-based games	Non-User	28	0.00	0.00	0.33	0.19
	User	215	0.11	0.57	0.01	
Cautiousness of security implications	Non-User	28	2.92	1.20	0.04	0.25
	User	215	3.22	0.62	0.20	
Internet Mobile						
Frequency of monitoring location-based application	Non-User	57	0.32	0.95	0.02	0.34
	User	186	0.77	1.35	0.01	
Frequency of monitoring location-based games	Non-User	57	0.05	0.40	0.50	0.09
	User	186	0.11	0.58	0.42	
Cautiousness of security implications	Non-User	57	3.06	0.87	0.13	0.19
	User	186	3.22	0.66	0.20	
Internet Hotspot						
Frequency of monitoring location-based application	Non-User	131	0.48	1.10	0.02	0.28
	User	112	0.88	1.43	0.02	
Frequency of monitoring location-based games	Non-User	131	0.05	0.37	0.13	0.15
	User	112	0.15	0.69	0.15	
Cautiousness of security implications	Non-User	131	3.19	0.70	0.80	0.03
	User	112	3.17	0.73	0.80	

Hours Playing Mobile game		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	69	0.68	1.23	0.89	0.02
	User	174	0.66	1.30	0.88	
Frequency of monitoring location-based games	Non-User	69	0.04	0.36	0.35	0.12
	User	174	0.11	0.60	0.26	
Cautiousness of security implications	Non-User	69	3.08	0.81	0.17	0.17
	User	174	3.22	0.67	0.21	

Hours Playing Computer games						
Frequency of monitoring location-based application	Non-User	55	0.65	1.25	0.96	0.01
	User	188	0.66	1.29	0.96	
Frequency of monitoring location-based games	Non-User	55	0.02	0.13	0.23	0.16
	User	188	0.12	0.61	0.04	
Cautiousness of security implications	Non-User	55	3.10	0.91	0.31	0.12
	User	188	3.21	0.65	0.40	
Total free time playing games						
Frequency of monitoring location-based application	Non-User	149	0.60	1.20	0.32	0.12
	User	94	0.77	1.39	0.33	
Frequency of monitoring location-based games	Non-User	149	0.04	0.37	0.05	0.19
	User	94	0.18	0.73	0.09	
Cautiousness of security implications	Non-User	149	3.18	0.73	0.88	0.02
	User	94	3.19	0.69	0.87	

Battle Net		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	190	0.66	1.27	0.99	0.00
	User	53	0.66	1.30	0.99	
Frequency of monitoring location-based games	Non-User	190	0.09	0.53	0.78	0.04
	User	53	0.11	0.58	0.79	
Cautiousness of security implications	Non-User	190	3.19	0.72	0.72	0.06
	User	53	3.15	0.68	0.71	
Origin						
Frequency of monitoring location-based application	Non-User	212	0.64	1.24	0.41	0.14
	User	31	0.84	1.49	0.48	
Frequency of monitoring location-based games	Non-User	212	0.08	0.47	0.15	0.17
	User	31	0.23	0.88	0.36	
Cautiousness of security implications	Non-User	212	3.19	0.75	0.86	0.03
	User	31	3.16	0.43	0.79	
PlayStation Network (PSN)						
Frequency of monitoring location-based application	Non-User	215	0.67	1.28	0.69	0.08
	User	28	0.57	1.23	0.68	
Frequency of monitoring location-based games	Non-User	215	0.09	0.51	0.62	0.07
	User	28	0.14	0.76	0.71	
Cautiousness of security implications	Non-User	215	3.18	0.69	0.73	0.06
	User	28	3.23	0.90	0.78	
Steam						
Frequency of monitoring location-based application	Non-User	155	0.60	1.23	0.31	0.13
	User	88	0.77	1.36	0.33	
Frequency of monitoring location-based games	Non-User	155	0.08	0.52	0.51	0.08
	User	88	0.13	0.58	0.53	
Cautiousness of security implications	Non-User	155	3.20	0.74	0.57	0.07
	User	88	3.15	0.66	0.55	
Windows Live						
Frequency of monitoring location-based application	Non-User	190	0.62	1.24	0.28	0.15
	User	53	0.83	1.41	0.32	
Frequency of monitoring location-based games	Non-User	190	0.04	0.34	0.00	0.25
	User	53	0.28	0.95	0.07	
Cautiousness of security implications	Non-User	190	3.15	0.75	0.17	0.20
	User	53	3.30	0.55	0.10	

Xbox Live						
Frequency of monitoring location-based application	Non-User	212	0.64	1.27	0.50	0.12
	User	31	0.81	1.35	0.53	
Frequency of monitoring location-based games	Non-User	212	0.09	0.51	0.71	0.05
	User	31	0.13	0.72	0.77	
Cautiousness of security implications	Non-User	212	3.15	0.73	0.09	0.32
	User	31	3.39	0.53	0.03	

Shooter		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	177	0.61	1.25	0.30	0.14
	User	66	0.80	1.35	0.31	
Frequency of monitoring location-based games	Non-User	177	0.03	0.28	0.00	0.24
	User	66	0.26	0.92	0.06	
Cautiousness of security implications	Non-User	177	3.18	0.77	0.90	0.02
	User	66	3.19	0.53	0.88	
Massive Multiplayer Online Role Playing Game (MMORPG)						
Frequency of monitoring location-based application	Non-User	207	0.64	1.27	0.56	0.10
	User	36	0.78	1.33	0.57	
Frequency of monitoring location-based games	Non-User	207	0.08	0.51	0.39	0.12
	User	36	0.17	0.70	0.49	
Cautiousness of security implications	Non-User	207	3.18	0.74	0.98	0.00
	User	36	3.19	0.57	0.98	
Strategy						
Frequency of monitoring location-based application	Non-User	208	0.66	1.27	0.91	0.02
	User	35	0.69	1.35	0.91	
Frequency of monitoring location-based games	Non-User	208	0.07	0.47	0.05	0.22
	User	35	0.26	0.85	0.21	
Cautiousness of security implications	Non-User	208	3.19	0.70	0.72	0.06
	User	35	3.14	0.79	0.75	

Buy In Store		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	144	0.72	1.37	0.38	0.11
	User	99	0.58	1.13	0.36	
Frequency of monitoring location-based games	Non-User	144	0.05	0.38	0.11	0.16
	User	99	0.16	0.71	0.15	
Cautiousness of security implications	Non-User	144	3.15	0.76	0.40	0.10
	User	99	3.23	0.64	0.38	
Buy Online						
Frequency of monitoring location-based application	Non-User	203	0.63	1.27	0.38	0.15
	User	40	0.83	1.30	0.39	
Frequency of monitoring location-based games	Non-User	203	0.08	0.52	0.48	0.10
	User	40	0.15	0.66	0.55	
Cautiousness of security implications	Non-User	203	3.20	0.69	0.30	0.16
	User	40	3.08	0.81	0.35	
Buy Downloadable Content						
Frequency of monitoring location-based application	Non-User	196	0.65	1.27	0.81	0.04
	User	47	0.70	1.33	0.82	
Frequency of monitoring location-based games	Non-User	196	0.05	0.39	0.01	0.24
	User	47	0.28	0.93	0.11	
Cautiousness of security implications	Non-User	196	3.16	0.75	0.44	0.12
	User	47	3.26	0.55	0.35	

Buy Special Edition						
Frequency of monitoring location-based application	Non-User	203	0.72	1.32	0.09	0.28
	User	40	0.35	0.98	0.04	
Frequency of monitoring location-based games	Non-User	203	0.08	0.52	0.48	0.10
	User	40	0.15	0.66	0.55	
Cautiousness of security implications	Non-User	203	3.18	0.74	0.74	0.06
	User	40	3.22	0.55	0.69	
Buy Pre-order Games						
Frequency of monitoring location-based application	Non-User	212	0.67	1.28	0.94	0.02
	User	31	0.65	1.25	0.93	
Frequency of monitoring location-based games	Non-User	212	0.07	0.46	0.03	0.25
	User	31	0.29	0.90	0.18	
Cautiousness of security implications	Non-User	212	3.17	0.74	0.65	0.08
	User	31	3.24	0.51	0.56	

Action Adventure		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	207	0.56	1.18	0.00	0.42
	User	36	1.25	1.65	0.02	
Frequency of monitoring location-based games	Non-User	207	0.06	0.39	0.01	0.24
	User	36	0.31	1.04	0.17	
Cautiousness of security implications	Non-User	207	3.17	0.73	0.60	0.09
	User	36	3.24	0.59	0.54	
Strategy						
Frequency of monitoring location-based application	Non-User	205	0.64	1.24	0.51	0.10
	User	38	0.79	1.47	0.56	
Frequency of monitoring location-based games	Non-User	205	0.10	0.55	0.85	0.03
	User	38	0.08	0.49	0.83	
Cautiousness of security implications	Non-User	205	3.17	0.74	0.55	0.10
	User	38	3.25	0.57	0.48	
Board Games						
Frequency of monitoring location-based application	Non-User	220	0.65	1.25	0.64	0.09
	User	23	0.78	1.54	0.69	
Frequency of monitoring location-based games	Non-User	220	0.07	0.46	0.05	0.23
	User	23	0.30	1.02	0.29	
Cautiousness of security implications	Non-User	220	3.18	0.73	0.89	0.03
	User	23	3.20	0.53	0.85	

Buy Downloadable Content		N	Mean	Std. Deviation	p-Value	Effect size
Frequency of monitoring location-based application	Non-User	218	0.63	1.24	0.29	0.18
	User	25	0.92	1.55	0.38	
Frequency of monitoring location-based games	Non-User	218	0.07	0.46	0.03	0.25
	User	25	0.32	0.99	0.22	
Cautiousness of security implications	Non-User	218	3.17	0.73	0.31	0.21
	User	25	3.32	0.55	0.21	
Buy Special Edition						
Frequency of monitoring location-based application	Non-User	160	0.58	1.18	0.17	0.17
	User	83	0.82	1.44	0.20	
Frequency of monitoring location-based games	Non-User	160	0.05	0.37	0.07	0.17
	User	83	0.18	0.77	0.15	
Cautiousness of security implications	Non-User	160	3.13	0.78	0.11	0.20
	User	83	3.29	0.54	0.07	

Security Awareness Comparison		N	Mean	Std. Deviation	p-Value	Effect size
Pair 1	Frequency of monitoring location-based applications	0.66	243.00	1.28	0.02	1.97
	Cautiousness of security implications	3.18	243.00	0.71		
Pair 2	Frequency of monitoring location-based games	0.09	243.00	0.54	0.97	4.33
	Cautiousness of security implications	3.18	243.00	0.71		

Appendix 3 Example of ranking the importance of the aspects needed in the location-based development process questionnaire

Ranking of aspect needed for the location-based game development process

The gaming industry is one of the most profitable software industries in the world. Although the gaming industry is one of the largest, fast growing and complex software industries the research is still in its infancy. This fact opens an opportunity for researchers to develop better methodologies and techniques for developing games. This research project will endeavour to develop a systems development methodology that better fit the development of location based games. The SDM will be developed by using aspects needed for the development process of a location based game.

Please Rank the importance of the following aspects in regards to developing a location based game. Furthermore please indicate aspects that may have been overlooked and can be added to the study.

* Required

Rank the importance of Player Experience *

The player experience is concerned with all aspects about the player's experience while playing the game.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Usability *

Usability can be described as the ability of a game to be easily understood, learned without training or extensive background, usefulness and attractiveness to the player.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Cognitive Support *

Cognitive Support can be described as increasing the game's controls and logical flow of the game to allow the player to play the game by using their instinct.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Learnability *

Playing a game should be easy to learn and should not require training, gaming experience or background, which will ensure that the player will enjoy the game.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of the Value to the Player *

What makes a player choose a game above other is the value the game has for that player.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of User Interface Design *

A well designed and executed user interface design.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Availability and Accessibility *

The ability for location based games to be downloaded via different platforms' online stores.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Adaptability *

The location based game should be adaptable to the context of the game and the player specifications.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Compatibility *

The location based games compatibility regarding different platforms and handheld devices.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Efficiency *

The efficiency of the game regarding performance, aesthetics, communication and sensor utilisation.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Security and Privacy *

The security and privacy of location based data and communications.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Playability *

The enjoy-ability of the game.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Re-Playability *

Can be seen as the measurement of how enjoyable a game is based on the amount of time a player spends on playing the game.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Organisational Structure *

The cooperation of departments in the organisation.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Rank the importance of Development Team *

The cooperation of department members in the departments.

	1	2	3	4	5	6	7	8	9	10	
Least Important	○	○	○	○	○	○	○	○	○	○	Most Important

Suggestion 1 with ranking

Your answer

Suggestion 2 with ranking

Your answer

Suggestion 3 with ranking

Your answer

Suggestion 4 with ranking

Your answer

Appendix 4 Suitability analysis results

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
Playability (w=8.81)	C1: 0% C2: 10% C3: 10% A1: 15%	C1: 10% C2: 20% C3: 30% A1: 20%	C1: 5% C2: 20% C3: 10% A1: 15%	C1: 5% C2: 20% C3: 10% A1: 15%	C1: 5% C2: 20% C3: 10% A1: 30%	C1: 55% C2: 50% C3: 40% A1: 20%	C1: 90% C2: 100% C3: 85% A1: 100%	C1: 60% C2: 70% C3: 40% A1: 65%	32.97%
	AVG: 8.75=> 77.09	AVG: 20=> 176.2	AVG: 12.5=> 110.13	AVG: 12.5=> 110.13	AVG: 16.25=> 143.16	AVG: 41.25=> 363.41	AVG: 93.75=> 825.94	AVG: 58.75=> 517.59	
Player Experi-ence (w=8.70)	C1: 80% C2: 60% C3: 50% A1: 80%	C1: 50% C2: 50% C3: 60% A1: 60%	C1: 90% C2: 90% C3: 80% A1: 75%	C1: 90% C2: 90% C3: 85% A1: 85%	C1: 98% C2: 80% C3: 85% A1: 75%	C1: 95% C2: 80% C3: 90% A1: 80%	C1: 98% C2: 100% C3: 90% A1: 95%	C1: 95% C2: 100% C3: 90% A1: 95%	81.91%
	AVG: 67.5=> 587.25	AVG: 55=> 478.5	AVG: 83.75=> 728.63	AVG: 87.5=> 761.25	AVG: 84.5=> 735.15	AVG: 86.25=> 750.38	AVG: 95.75=> 833.03	AVG: 95=> 826.5	
Usability (w=7.93)	C1: 96% C2: 70% C3: 50% A1: 85%	C1: 60% C2: 80% C3: 60% A1: 65%	C1: 95% C2: 75% C3: 50% A1: 80%	C1: 0% C2: 20% C3: 50% A1: 20%	C1: 97% C2: 80% C3: 80% A1: 80%	C1: 98% C2: 80% C3: 80% A1: 80%	C1: 95% C2: 100% C3: 80% A1: 85%	C1: 90% C2: 100% C3: 80% A1: 85%	73.31%
	AVG: 75.25=> 596.73	AVG: 66.25=> 525.36	AVG: 75=> 594.75	AVG: 22.5=> 178.43	AVG: 84.25=> 668.1	AVG: 84.5=> 670.09	AVG: 90=> 713.7	AVG: 88.75=> 703.79	
Value to the Player (w=7.67)	C1: 80% C2: 100% C3: 50% A1: 85%	C1: 85% C2: 100% C3: 60% A1: 85%	C1: 95% C2: 100% C3: 80% A1: 80%	C1: 95% C2: 100% C3: 80% A1: 85%	C1: 95% C2: 100% C3: 80% A1: 75%	C1: 95% C2: 100% C3: 80% A1: 80%	C1: 100% C2: 100% C3: 80% A1: 95%	C1: 100% C2: 100% C3: 80% A1: 95%	87.97%
	AVG: 78.75=> 604.01	AVG: 82.5=> 632.78	AVG: 88.75=> 680.71	AVG: 90=> 690.3	AVG: 87.5=> 671.13	AVG: 88.75=> 680.71	AVG: 93.75=> 719.06	AVG: 93.75=> 719.06	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
User Interface Design (w=7.47)	C1: 10% C2: 10% C3: 30% A1: 20%	C1: 50% C2: 60% C3: 55% A1: 55%	C1: 90% C2: 80% C3: 80% A1: 75%	C1: 0% C2: 10% C3: 50% A1: 20%	C1: 80% C2: 80% C3: 80% A1: 75%	C1: 90% C2: 90% C3: 80% A1: 85%	C1: 50% C2: 100% C3: 80% A1: 65%	C1: 100% C2: 100% C3: 25% A1: 85%	61.25%
	AVG: 17.5=> 130.73	AVG: 55=> 410.85	AVG: 81.25=> 606.94	AVG: 20=> 149.4	AVG: 78.75=> 588.26	AVG: 86.25=> 644.29	AVG: 73.75=> 550.91	AVG: 77.5=> 578.93	
Develop-ment Team (w=7.37)	C1: 0% C2: 5% C3: 20% A1: 20%	C1: 100% C2: 90% C3: 75% A1: 85%	C1: 50% C2: 50% C3: 50% A1: 60%	C1: 100% C2: 90% C3: 80% A1: 75%	C1: 100% C2: 90% C3: 80% A1: 85%	C1: 0% C2: 0% C3: 40% A1: 15%	C1: 50% C2: 50% C3: 75% A1: 50%	C1: 100% C2: 80% C3: 80% A1: 85%	60.31%
	AVG: 11.25=> 82.91	AVG: 87.5=> 644.88	AVG: 52.5=> 386.93	AVG: 86.25=> 635.66	AVG: 88.75=> 654.09	AVG: 13.75=> 101.34	AVG: 56.25=> 414.56	AVG: 86.25=> 635.66	
Re-Playability (w=7.34)	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 0% C2: 20% C3: 65% A1: 10%	C1: 0% C2: 0% C3: 30% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 20% C3: 20% A1: 10%	C1: 65% C2: 60% C3: 50% A1: 50%	C1: 100% C2: 100% C3: 80% A1: 100%	C1: 70% C2: 80% C3: 80% A1: 65%	35.47%
	AVG: 7.5=> 55.05	AVG: 23.75=> 174.33	AVG: 10=> 73.4	AVG: 5=> 36.7	AVG: 12.5=> 91.75	AVG: 56.25=> 412.88	AVG: 95=> 697.3	AVG: 73.75=> 541.33	
Learnabilit y (w=7.15)	C1: 0% C2: 5% C3: 10% A1: 15%	C1: 0% C2: 10% C3: 30% A1: 20%	C1: 40% C2: 50% C3: 40% A1: 60%	C1: 0% C2: 0% C3: 10% A1: 20%	C1: 45% C2: 40% C3: 50% A1: 30%	C1: 60% C2: 50% C3: 50% A1: 40%	C1: 55% C2: 70% C3: 50% A1: 55%	C1: 50% C2: 60% C3: 50% A1: 60%	35.16%
	AVG: 7.5=> 53.63	AVG: 15=> 107.25	AVG: 47.5=> 339.63	AVG: 7.5=> 53.63	AVG: 41.25=> 294.94	AVG: 50=> 357.5	AVG: 57.5=> 411.13	AVG: 55=> 393.25	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
Efficiency (w=7.14)	C1: 100% C2: 80% C3: 65% A1: 80%	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 15%	C1: 50% C2: 60% C3: 30% A1: 50%	C1: 0% C2: 20% C3: 10% A1: 10%	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 0% C2: 10% C3: 10% A1: 10%	21.56%
	AVG: 81.25=> 580.13	AVG: 7.5=> 53.55	AVG: 5=> 35.7	AVG: 6.25=> 44.63	AVG: 47.5=> 339.15	AVG: 10=> 71.4	AVG: 7.5=> 53.55	AVG: 7.5=> 53.55	
Security and Privacy (w=7.11)	C1: 100% C2: 80% C3: 50% A1: 80%	C1: 0% C2: 10% C3: 10% A1: 15%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 55% C2: 50% C3: 30% A1: 40%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 25% C3: 10% A1: 10%	20.47%
	AVG: 77.5=> 551.03	AVG: 8.75=> 62.21	AVG: 5=> 35.55	AVG: 7.5=> 53.33	AVG: 43.75=> 311.06	AVG: 5=> 35.55	AVG: 5=> 35.55	AVG: 11.25=> 79.99	
Availability and Accessi-bility (w=7.07)	C1: 0% C2: 10% C3: 30% A1: 0%	C1: 0% C2: 10% C3: 10% A1: 0%	C1: 100% C2: 90% C3: 10% A1: 80%	C1: 0% C2: 0% C3: 10% A1: 0%	C1: 100% C2: 90% C3: 80% A1: 80%	C1: 0% C2: 0% C3: 10% A1: 0%	C1: 0% C2: 20% C3: 10% A1: 0%	C1: 0% C2: 20% C3: 10% A1: 0%	24.06%
	AVG: 10=> 70.7	AVG: 5=> 35.35	AVG: 70=> 494.9	AVG: 2.5=> 17.68	AVG: 87.5=> 618.63	AVG: 2.5=> 17.68	AVG: 7.5=> 53.03	AVG: 7.5=> 53.03	
Cognitive Support (w=6.90)	C1: 80% C2: 80% C3: 40% A1: 75%	C1: 0% C2: 20% C3: 10% A1: 10%	C1: 85% C2: 80% C3: 10% A1: 50%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 50% C2: 40% C3: 40% A1: 40%	C1: 90% C2: 80% C3: 80% A1: 60%	C1: 100% C2: 100% C3: 80% A1: 70%	C1: 100% C2: 100% C3: 80% A1: 65%	54.22%
	AVG: 68.75=> 474.38	AVG: 10=> 69	AVG: 56.25=> 388.13	AVG: 5=> 34.5	AVG: 42.5=> 293.25	AVG: 77.5=> 534.75	AVG: 87.5=> 603.75	AVG: 86.25=> 595.13	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

	SDLC	Scrum	MASAM	Mobile-D	RAD with DSDM Atern	MDA Framework	Playability and Re-playability	Player-centred game design	Suit-ability of aspects across SDMs
Compati-bility (w=6.62)	C1: 100% C2: 80% C3: 65% A1: 80%	C1: 0% C2: 10% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 10% A1: 15%	C1: 50% C2: 60% C3: 50% A1: 60%	C1: 0% C2: 10% C3: 50% A1: 15%	C1: 0% C2: 10% C3: 80% A1: 15%	C1: 0% C2: 10% C3: 80% A1: 10%	C1: 0% C2: 10% C3: 20% A1: 10%	28.75%
	AVG: 81.25=> 537.88	AVG: 7.5=> 49.65	AVG: 6.25=> 41.38	AVG: 55=> 364.1	AVG: 18.75=> 124.13	AVG: 26.25=> 173.78	AVG: 25=> 165.5	AVG: 10=> 66.2	
Adapta-bility (w=6.40)	C1: 90% C2: 80% C3: 40% A1: 75%	C1: 0% C2: 20% C3: 40% A1: 20%	C1: 50% C2: 60% C3: 30% A1: 65%	C1: 0% C2: 0% C3: 10% A1: 10%	C1: 0% C2: 0% C3: 40% A1: 15%	C1: 95% C2: 90% C3: 60% A1: 80%	C1: 100% C2: 90% C3: 60% A1: 80%	C1: 100% C2: 90% C3: 60% A1: 80%	50.94%
	AVG: 71.25=> 456	AVG: 20=> 128	AVG: 51.25=> 328	AVG: 5=> 32	AVG: 13.75=> 88	AVG: 81.25=> 520	AVG: 82.5=> 528	AVG: 82.5=> 528	
Organi-sational Structure (w=6.23)	C1: 65% C2: 40% C3: 40% A1: 55%	C1: 90% C2: 80% C3: 60% A1: 85%	C1: 50% C2: 60% C3: 30% A1: 60%	C1: 55% C2: 40% C3: 40% A1: 65%	C1: 80% C2: 80% C3: 75% A1: 80%	C1: 0% C2: 0% C3: 10% A1: 65%	C1: 60% C2: 40% C3: 50% A1: 65%	C1: 90% C2: 80% C3: 80% A1: 75%	57.66%
	AVG: 50=> 311.5	AVG: 78.75=> 490.61	AVG: 50=> 311.5	AVG: 50=> 311.5	AVG: 78.75=> 490.61	AVG: 18.75=> 116.81	AVG: 53.75=> 334.86	AVG: 81.25=> 506.19	
Suitability of SDM	47.03%	36.74%	46.91%	31.60%	55.60%	49.59%	63.14%	61.85%	

Appendix 5 Detailed mapping of the aspects, steps and techniques to the method of the DMLBG

Phases of DMLBG	Aspects	Steps and techniques	SDMs
Phase 1: Research Phase			
1.1. Decide initial concept of game	Player Experience	Requirement gathering	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Usability	List game features	Playability and Re-playability
	Value to the Player	Concept design for different players	Player-centred game design
	User Interface Design	Aesthetics model design	MDA Framework
1.2. Identify key specialists for initial phases	Development Team	Concept development with entire team (all departments)	Scrum, RAD with DSDM Atern
	Organisational Structure	Development process cannot be planned from beginning to	Scrum, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		end	
1.3. Concept development			
1.3.1. List game features	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	List game features	Playability and Re-playability
	Value to the Player	Collection of player requirements	SDLC, Scrum, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	User Interface Design	Production that keeps the different players in mind	Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Requirement gathering	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
1.3.2. Estimate scores for game features	Playability	Adjust game features based on score	Playability and Re-playability
	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features	Playability and Re-playability
	Value to the Player	Developers should also refine the player audience	Player-centred game design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Player-centred game design
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
1.3.3. Determine game category	Playability	Adjust game features based on score	Playability and Re-playability
	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features	Playability and Re-playability
	Value to the	Developers	Player-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	should also refine the player audience	centred game design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Player-centred game design
1.3.4. Adjust game concept	Playability	Adjust game features based on score	Playability and Re-playability
	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features	Playability and Re-playability
	Value to the Player	Developers should also refine the player audience	Player-centred game design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
1.4. Market research	Value to the Player	Collection of player requirements	SDLC, Scrum, MASAM, Mobile-D, RAD with DSDM Atern, MDA Framework, Playability and Re-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning	SDLC, Mobile-D
	Adaptability	Determine the games category and adjust game accordingly	Playability and Re-playability
1.5. Research accuracy of game concepts	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	Estimate scores for game features	Playability and Re-playability
	Value to the Player	Concept design for different players	Player-centred game design
	Efficiency	Design, integration and testing	

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
Phase 2: Concept Phase			
2.1. Feasibility study			
2.1.1. Determine feasible solution	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
2.1.2. Identify every possible approach	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
2.1.3. Illustrate organizational factors	Development Team	Agile development environment	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			design
	Organisational Structure	Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
2.1.4. Provide playability and re-playability factors	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Re-Playability	Adjust game according to score to fit a specific category	MDA Framework, Playability and Re-playability, Player-centred game design
2.1.5. Cost analysis and planning	Development Team	Feasibility study with all departments	Scrum, Mobile-D, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Compatibility	Release and deployment planning	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
	Organisational Structure	Feasibility study with all departments	Scrum, RAD with DSDM Atern
2.2. Functionality planning			
2.2.1. Compile revised description and adaptability specification	Development Team	Feasibility study with all departments	Scrum, Mobile-D, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			centred game design
2.2.2. Consider in game play feedback	Player Experience	Try to satisfy all types of gamers	Player-centred game design
	Usability	Repeat the process until the players are satisfied	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Player feedback	SDLC, Scrum, MASAM, Playability and Re-playability, Player-centred game design
	User Interface Design	Post-production that used player feedback for next project	RAD with DSDM Atern, MDA Framework, Player-centred game design
	Learnability	Feedback and suggestions from the players	MASAM, RAD with DSDM Atern, MDA Framework, Playability

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			and Re-playability, Player-centred game design
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
2.2.3. Adaptability features			
2.2.3.1. Identify different states of the game	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Try to satisfy all types of gamers	Player-centred game design
	Usability	Adjust game features based on score	Playability and Re-playability

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Value to the Player	Presentation of intermediate products	Scrum, Mobile-D, MDA Framework, Player-centred game design
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
	Adaptability	Re-playability factors	Playability and Re-playability
2.2.3.2. Determine different game and adaptability features for each game state	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Try to satisfy all types of gamers	Player-centred game design
	Usability	Adjust game features based on score	Playability and Re-playability
	Value to the	Presentation of	Scrum, Mobile-D,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	intermediate products	MDA Framework, Player-centred game design
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Re-playability factors	Playability and Re-playability
2.2.3.3. Determine adaptability features for dynamic model	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Dynamic model	MDA Framework
	Re-Playability	Adjust game according to score to fit a specific category	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Re-playability factors	Playability and Re-playability
2.2.3.4. Determine adaptability features for mechanic model	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Dynamic model	MDA Framework
	Re-Playability	Adjust game according to score to fit a specific category	MDA Framework, Playability and Re-playability, Player-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Re-playability factors	Playability and Re-playability
2.2.3.5. Determine adaptability feature for game settings	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the	Dynamic	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	model	Framework
	Re-Playability	Adjust game according to score to fit a specific category	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Re-playability factors	Playability and Re-playability
2.2.3.6. Determine design implication for adaptability	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Adaptability	Iterative development of a dynamic model Iterative development of a mechanic model	MDA Framework
2.3. Preliminary context design			
2.3.1. Identify resources needed for the game	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	List game features	Playability and Re-playability
	Value to the Player	Aesthetics model design	MDA Framework
	User Interface Design	Aesthetics model design	MDA Framework
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
2.3.2. Identify specialists needed for the game	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Agile development environment Product sharing and environmental setup Scrum	Scrum, RAD with DSDM Atern, Player-centred game design
2.3.3. Identify the contextual information usage in the game	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	List game features	Playability and Re-playability
	Value to the	Aesthetics	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	model design	Framework
	User Interface Design	Aesthetics model design	MDA Framework
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
2.3.4. Decide counter-plan and action if plans if resources are not available	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	List game features	Playability and Re-playability
	Value to the Player	Aesthetics model design	MDA Framework
	User Interface	Aesthetics	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Design	model design	Framework
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
2.3.5. Decide how resources will be used in the game	Player Experience	Use similar games as guidelines	SDLC, MASAM, Mobile-D, RAD with DSDM Atern
	Usability	List game features	Playability and Re-playability
	Value to the Player	Aesthetics model design	MDA Framework
	User Interface Design	Aesthetics model design	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Learnability	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
2.4. Security			
2.4.1. Identify game data that is sensitive	Development Team	Agile development environment	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Organisational Structure	Development process cannot be planned from beginning to end Feasibility study with all departments	Scrum, RAD with DSDM Atern
2.4.2. Identify network packets that are sensitive	Development Team	Agile development environment	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Organisational Structure	Development process cannot be planned from beginning to end Feasibility study with all departments	Scrum, RAD with DSDM Atern
2.4.3. Identify other security weaknesses	Development Team	Agile development environment	Scrum, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Organisational Structure	Development process cannot be planned from beginning to end Feasibility study with all departments	Scrum, RAD with DSDM Atern
2.4.4. Choose valid action for weaknesses, data and network	Development Team	Agile development environment	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Organisational Structure	Development process cannot be	Scrum, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		planned from beginning to end Feasibility study with all departments	Atern
2.5. Initial game flow design			
2.5.1 Identify major cognitive process flows with in the game	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
2.5.2. Develop storyboard for game flow	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Playability and Re-playability, Player-centred game design
2.5.3. Determine game type and experience to navigate different process flows	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Framework, Playability and Re-playability, Player-centred game design
2.5.4. Revise storyboard to include in game tutorial based on previous step	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC
	Cognitive	Involvement of	SDLC, MASAM,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Support	game players	MDA Framework, Playability and Re-playability, Player-centred game design
2.5.5. Develop first draft of aesthetic model	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC
	Cognitive	Involvement of	SDLC,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Support	game players	MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
2.5.6. Present set of storyboards to testers	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
2.5.7. Present aesthetic model to testers	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework
	Efficiency	Design, integration	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		and testing	
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
2.5.8. Modify storyboards to accommodate tester input	Player Experience	Involve players	SDLC, MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	List game features Design the game interface	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability
	Value to the Player	Aesthetics model	MDA Framework
	User Interface Design	Iteratively tuning aesthetics model	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Involvement of game players	SDLC, MASAM, MDA Framework, Playability and Re-playability, Player-centred game design
Phase 3: Pre-Design Phase			
3.1. Assemble team			
3.1.1. Identify specialists	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Scrum	Scrum, RAD with DSDM Atern, Player-centred game design
3.1.2. Identify organisational departments' involvement	Development Team	Agile development environment	Scrum, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		Development process cannot be planned from beginning to end	Atern
	Organisational Structure	Product sharing and environmental setup	Scrum, RAD with DSDM Atern, Player-centred game design
3.1.3. Identify specialists that need to work as pairs	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design
3.2. Exploration			
3.2.1. Discuses requirements identified in new team	Development Team	Agile development environment Development process cannot be planned from beginning to	Scrum, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		end	
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design
3.2.2. Discuses needs of game in new team	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design
3.2.3. Develop functional solution	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup	Scrum, RAD with DSDM Atern, Player-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		Extreme programming elements	centred game design
3.3. Get identified team up to date	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design
3.4. Plan forward			
3.4.1. Plan for the next phases	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
3.4.2. Integrate previous and upcoming outputs	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Extreme programming elements	Scrum, RAD with DSDM Atern, Player-centred game design
Phase 4: Design Phase			
4.1. Game Identity			
4.1.1. Develop framework for game			
4.1.1.1. Identify core programmer design	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Usability	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Value to the	Mechanic	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	model Dynamic model Aesthetics model	Framework
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
	Adaptability	Six aspects of playability	Playability and Re-playability
4.1.1.2. Identify graphics design	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Usability	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Value to the	Mechanic	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	model Dynamic model Aesthetics model	Framework
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
	Adaptability	Six aspects of playability	Playability and Re-playability
4.1.1.3. Identify art design	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Usability	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Value to the	Mechanic	MDA

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Player	model Dynamic model Aesthetics model	Framework
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
	Adaptability	Six aspects of playability	Playability and Re-playability
4.1.1.4. Identify network design	Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Usability	Mechanic model Dynamic model Aesthetics model	MDA Framework
	Value to the Player	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Re-Playability	Design, integration and testing	SDLC
	Efficiency	Designing for completion	Playability and Re-playability
	Cognitive Support	Six aspects of playability	Playability and Re-playability
	Adaptability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
4.1.1.5. Identify sound design	Playability	List game features and estimate score based on	MDA Framework, Playability and Re-playability,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		playability	Player-centred game design
	Usability	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Value to the Player	Mechanic model Dynamic model Aesthetics model	MDA Framework
	Re-Playability	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
	Adaptability	Six aspects of playability	Playability and Re-playability
4.1.1.6. Identify security design	Player Experience	List game features and estimate score based on	MDA Framework, Playability and Re-playability,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		playability	Player-centred game design
	Usability	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Value to the Player	Mechanic model Dynamic model Aesthetics model	MDA Framework
	Efficiency	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
	Compatibility	Six aspects of playability	Playability and Re-playability
4.1.1.7. Identify AI design	Playability	List game features and estimate score based on	MDA Framework, Playability and Re-playability,

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		playability	Player-centred game design
	Player Experience	Create prototypes to present to a player group	MASAM, RAD with DSDM Atern
	Usability	Mechanic model Dynamic model Aesthetics model	MDA Framework
	Efficiency	List game features and estimate score based on playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Security and Privacy	Design, integration and testing	SDLC
	Cognitive Support	Designing for completion	Playability and Re-playability
4.1.2. Integrate design from different specialists	Development Team	Agile development environment Concept development with entire team (all departments)	Scrum, RAD with DSDM Atern

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Organisational Structure	Product sharing and environmental setup Scrum Rational Unified Process elements	Scrum, RAD with DSDM Atern, Player-centred game design
4.2. Analyse game framework with entire team	Development Team	Agile development environment Concept development with entire team (all departments)	Scrum, RAD with DSDM Atern
	Organisational Structure	Product sharing and environmental setup Scrum Rational Unified Process elements	Scrum, RAD with DSDM Atern, Player-centred game design
4.3. Design Planning			
4.3.1. Refine cost and design implications	Development Team	Agile development environment Development process cannot be planned from beginning to end	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
	Organisational Structure	Crystal methodologies elements	RAD with DSDM Atern
4.3.2. Determine different platforms for deploying game	Efficiency	Design, integration and testing	SDLC
	Availability and Accessibility	Focus on how the market plays a role in the game's success	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
4.3.3. Compile compatibility list	Efficiency	Design, integration and testing	SDLC

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Availability and Accessibility	Focus on how the market plays a role in the game's success Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Concept development	Playability and Re-playability, Player-centred game design
4.4. Design			
4.4.1. Implement logical design according to specifications	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		SDLC, Scrum, MDA Framework
4.4.2. Implement physical design according to specifications	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		SDLC, Scrum, MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
Phase 5: Development Phase			
5.1. Development Planning			
5.1.1. Identify standards	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model Iterative development of a dynamic model	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.1.2. Identify development environment, tools and techniques	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model Iterative development of a dynamic model	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.1.3. Identify implementation plan	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model Iterative development of a dynamic	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		model	
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.1.4. Identify Integration plan	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model Iterative development	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		of a dynamic model	
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.1.5. Identify development plan	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model Iterative	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		development of a dynamic model	
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.1.6. Develop integration plan based on development plan	Development Team	Agile development environment Extreme programming elements	Scrum, RAD with DSDM Atern
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Iterative development of a mechanic model	MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		Iterative development of a dynamic model	
	Organisational Structure	Crystal methodologies elements Rational Unified Process elements	RAD with DSDM Atern
5.2. Development			
5.2.1. Specialist develop prototype			
5.2.1.1. Integrate test results from previous integrated prototype testing if There are any	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum MDA Framework MASAM Mobile-D RAD with DSDM Atern Playability and Re-playability Player-centred game design
5.2.1.2. Develop new prototype if first iteration else develop new prototype based on the previous iteration	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for		Scrum MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	location-based games, it is included to enhance the flow of DMLBG.		MASAM Mobile-D RAD with DSDM Atern Playability and Re-playability Player-centred game design
5.2.2. Paired integration			
5.2.2.1. Different team members team up to integrate developed prototypes to form one large integrated prototype	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum MDA Framework RAD with DSDM Atern
5.2.3. Implement each integrated prototype	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum MDA Framework RAD with DSDM Atern
5.2.3.1. Implement integrated prototype in test environment	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the		Scrum MDA Framework

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	development process for location-based games, it is included to enhance the flow of DMLBG.		RAD with DSDM Atern
5.2.3.2. Hand integrated prototype over to testers	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum MDA Framework RAD with DSDM Atern
Phase 6: Testing Phase			
6.1. Integrated testing			
6.1.2. Test each implementation of integrated prototype	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Prototype the user interface to the player Test on prospective player Assume that the game does not have	MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		only one client	design
	Usability	Modify the application according to user feedback Repeat the process until the players are satisfied	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Player feedback	SDLC, Scrum, MASAM, Playability and Re-playability, Player-centred game design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Re-Playability	Refine the player audience	MDA Framework, Playability and Re-playability, Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Learnability	Player involvement Prototyping	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
	Organisational Structure	Agile development	Scrum, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		environment	Atern
6.2. Alpha testing	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Prototype the user interface to the player Test on prospective player Assume that the game does not have only one client	MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design
	Usability	Modify the application according to user feedback Repeat the process until the players are satisfied	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Player feedback	SDLC, Scrum, MASAM, Playability and Re-playability, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Re-Playability	Refine the player audience	MDA Framework, Playability and Re-playability, Player-centred game design
	Learnability	Player involvement Prototyping	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
	Organisational Structure	Agile development environment	Scrum, RAD with DSDM Atern
6.3. Beta testing	Playability	Six aspects of playability	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Prototype the user interface to the player Test on prospective player Assume that the game does not have	MASAM, Mobile-D, RAD with DSDM Atern, Playability and Re-playability, Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		only one client	
	Usability	Modify the application according to user feedback Repeat the process until the players are satisfied	SDLC, MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Value to the Player	Player feedback	SDLC, Scrum, MASAM, Playability and Re-playability, Player-centred game design
	User Interface Design	Player involvement	MASAM, RAD with DSDM Atern, MDA Framework, Player-centred game design
	Re-Playability	Refine the player audience	MDA Framework, Playability and Re-playability, Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	Learnability	Player involvement Prototyping	MASAM, RAD with DSDM Atern, MDA Framework, Playability and Re-playability, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
	Organisational Structure	Agile development	Scrum, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		environment	Atern
Phase 7: Tuning Phase			
7.1. Analyse problems identified in testing	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.2 Analyse tester or closed beta player's feedback	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.3 Apply six aspects of playability and re-playability	Playability	Six aspects of playability	Playability and Re-playability
	Player Experience	Use six aspects of playability and re-playability	Playability and Re-playability
	Re-Playability	Six aspects of playability	Playability and Re-

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			playability
	Efficiency	Design, integration and testing	SDLC
7.3.1. Tuning based on social reasons	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.3.2. Tuning based on completion	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.3.3. Tuning based on experience	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			design
7.3.4. Tuning based on challenging	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.3.5. Tuning based on mastery	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.3.6. Tuning based on impact	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, RAD with DSDM Atern, Playability and Re-playability Player-centred game design
7.4. Re-design development plan	The overall process of the SDMs were analysed to include this step. Although the step does not address a		Scrum, MDA Framework, RAD with

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		DSDM Atern, Playability and Re-playability Player-centred game design
Phase 8: Pre-Production Phase			
8.1. Marketing campaign (Integrated in phases 1 – 8)			
8.1.1. Design game name	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design
8.1.2. Design game logo	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design
8.1.3. Design marketing campaign	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of		Scrum, MDA Framework, Playability and Re-playability Player-centred

Phases of DMLBG	Aspects	Steps and techniques	SDMs
	DMLBG.		game design
8.1.4. Develop game branding	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design
8.2. Finalize game branding	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design
8.3. Finalize game marketing campaign	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design
8.4. Finalize tuning	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		Scrum, MDA Framework, Playability and Re-playability Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
Phase 9: Release Phase			
9.1. Support			
9.1.1. Setup support for the different platforms	Development Team	Agile development environment Product sharing and environmental setup	Scrum, RAD with DSDM Atern, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
			design
9.1.2. Setup support channels	Development Team	Agile development environment Product sharing and environmental setup	Scrum, RAD with DSDM Atern, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
9.1.3. Implement support communication channels	Development Team	Agile development	Scrum, RAD with DSDM

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		environment Product sharing and environmental setup	Atern, Player-centred game design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
9.1.4. Implement support team	Development Team	Agile development environment Product sharing and environmental	Scrum, RAD with DSDM Atern, Player-centred game

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		setup	design
	Efficiency	Design, integration and testing	SDLC
	Security and Privacy	Design, integration and testing	SDLC
	Availability and Accessibility	Market-centred deployment	MASAM, RAD with DSDM Atern
	Compatibility	Release and deployment planning Identify devices and platforms for deployment	SDLC, Mobile-D
	Adaptability	Feedback and suggestions from players	SDLC, MDA Framework, Player-centred game design
9.2. Pre-Release			
9.2.1. Ensure game is ready for deployment on all platforms	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		SDLC, Scrum, Mobile-D

Phases of DMLBG	Aspects	Steps and techniques	SDMs
9.2.2. Ensure deployment for each platform market is understood	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		SDLC, Scrum, Mobile-D
9.3. Deploy game	The overall process of the SDMs were analysed to include this step. Although the step does not address a specific aspect of the development process for location-based games, it is included to enhance the flow of DMLBG.		SDLC, Scrum, Mobile-D
Phase 10: Monitoring Phase			
10.1. Allow players to give feedback in-game	Playability	Player feedback for next game or to make game more playable	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Try to satisfy all types of gamers Assume that the game does not have only one client	Player-centred game design
	Usability	Modify the application according to	SDLC, MASAM, RAD with

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		user feedback	DSDM Atern, MDA Framework
	Value to the Player	Developers should also refine the player audience	Player-centred game design
	Re-Playability	Player feedback for next game or to make game more playable	MDA Framework, Playability and Re-playability, Player-centred game design
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design
10.2. Setup different social media channels for player feedback	Playability	Player feedback for next game or to make game more playable	MDA Framework, Playability and Re-playability, Player-centred game design
	Player Experience	Try to satisfy all types of gamers Assume that	Player-centred game design

Phases of DMLBG	Aspects	Steps and techniques	SDMs
		the game does not have only one client	
	Usability	Modify the application according to user feedback	SDLC, MASAM, RAD with DSDM Atern, MDA Framework
	Value to the Player	Developers should also refine the player audience	Player-centred game design
	Re-Playability	Player feedback for next game or to make game more playable	MDA Framework, Playability and Re-playability, Player-centred game design
	Cognitive Support	Involvement of game players	SDLC, MASAM, Playability and Re-playability, Player-centred game design

Appendix 6 Results of analysing documentation from using DMLBG

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
Phase 1: Research Phase				
1.1. Decide initial concept of game	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The initial concept of the location-based games was identified. In addition, the first draft of the location-based games was also developed. The teams used the aspects associated with this step for the identification of concepts as well as for the first draft of the games. Teams also decided on the basic mechanics of the location-based games, such as that it is going to be a 'TAG', RPG, real-time strategy or real-time trading game. The decision to make the location-based games a single and/or multiplayer game was also made.		Yes
1.2. Identify key specialists for initial phases	LP : Yes; CR: Yes ; CA : Yes; SK : Yes	The teams identified the organisational structure and the project manager divided the teams into different specialist areas based on their skills.		Yes
1.3. Concept development				
1.3.1. List game features	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams did research on features that could be included to make their location-based game a success. Through this the teams identified the core features of the location-based games. Additional features unique to each team's game were also identified and included.		Yes
1.3.2. Estimate scores for game features	LP : Yes; CR: Yes; CA : Yes; SK : Yes	A scoring model was used to score the features as well as the unique features according to importance. This determined the priority of development for each feature.	Using a scoring matrix	Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
1.3.3. Determine game category	LP : Yes; CR: Yes; CA : Yes; SK : Yes	An analysis was done on different game genres to determine the game genre of the location-based game each team was going to develop. Each team identified the game genre in which their location-based game was going to be.		Yes
1.3.4. Adjust game concept	LP : Yes; CR: Yes; CA : Yes; SK : Yes	After identifying the location-based games' features the team adjusted the game concept with better understanding of what would be required for the development of their location-based game.		Yes
1.4. Market research	LP : Yes; CR: Yes; CA : Yes ; SK : Yes	Each team conducted a related market research study to determine if their location-based game was a viable product. The analysis included other successful and similar location-based games. This was done in order to determine what made them a successful or a failed location-based game. The team included the success factors that could be determined from the study and made the potential pitfalls visible.		Combine into one phase.
1.5. Research accuracy of game concepts	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The team conducted a related location-based game study. They identified different games from which they could learn. The team identified the successes and failures of different location-based games. The team also identified game mechanics that were used and that did not work and those that could possibly work.	Strengths, weaknesses, opportunities and threats analysis	Yes
Phase 2: Concept Phase				
2.1. Feasibility study				
2.1.1. Determine feasible solution	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Each of the teams started by determining the project goal. This included expanding on the different game features. The teams used a weighted decision matrix to refine the priority of the game features. The teams grouped the game features in different tasks. The feasibility of each of these tasks was determined.	Weighted score matrix, Feasibility matrix	Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.1.2. Identify every possible approach	LP : Partial; CR: Yes ; CA : Yes; SK : No	The development tasks were broken down into development activities. These activities were used to determine different approaches to achieve each of these tasks. The different approaches were combined to determine as many possible approaches as possible. The teams decided which approach would be used but also keeping the others as a back-up plan.		Yes
2.1.3. Illustrate organisational factors	LP : Partial; CR: No; CA : Partial; SK : No	This step did not add any value to the SDM.		No
2.1.4. Provide playability and re-playability factors	LP : Partial; CR: Yes ; CA : Yes; SK : No	Each of the development activities was analysed to determine how maximum playability and re-playability could be accomplished.		Yes
2.1.5. Cost analysis and planning	LP : Partial; CR: Partial; CA : Partial; SK : Partial	Laboratory Products identified each up-front cost analysis based on specialist rate per hour, as well as using the COCOMO model. This is a good estimation. Creativity based the cost on the specialist cost, number of specialists for each task, time, tools and techniques needed and overall management of project. The remaining teams did similar calculations.	COCOMO , Pert charts	Yes, step needs to be renamed to estimate cost.
2.2. Functionality planning				
2.2.1. Compile revised description and adaptability specifications	LP : Partial; CR: Partial; CA : Partial; SK : Partial	These steps did not add any value to the SDM.		No

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.2.2. Factor in gameplay feedback	LP : Partial; CR: Partial; CA : Partial; SK : Partial	These steps did not add any value to the SDM.		No
2.2.3. Adaptability features	LP : Partial; CR: Partial; CA : Partial; SK : Partial			No
2.2.3.1. Identify different states of the game	LP : Partial; CR: Partial; CA : Partial; SK : Partial			No
2.2.3.2. Determine different game and adaptability features for each game state	LP : Partial; CR: Partial; CA : Partial; SK : Partial			No
2.2.3.3. Determine adaptability features for dynamic model	LP : Partial; CR: Partial; CA : Partial; SK : Partial			No
2.2.3.4. Determine adaptability features for mechanic model	LP : Partial; CR: ; CA : ; SK :			No

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.2.3.5. Determine adaptability feature for game settings	LP : Partial; CR: Partial; CA : Partial; SK : Partial	These steps did not add any value to the SDM.		No
2.2.3.6. Determine design implications for adaptability	LP : Partial; CR: Partial; CA : Partial; SK : Partial			No
2.3. Preliminary context design				
2.3.1. Identify resources needed for the game	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams identified possible additional specialists and software and hardware tools and techniques needed to develop their location-based game.		Yes
2.3.2. Identify specialists needed for the game	LP : No; CR: No; CA : Partial; SK : Partial	These steps did not add any value to the SDM.		No
2.3.3. Identify the contextual information usage in the game	LP : No; CR: No; CA : Partial; SK : Partial			No
2.3.4. Decide counter-plan and action if plans if resources are not available	LP : Yes; CR: Partial; CA : No; SK : No	A project triangle was used to determine the cause and effect of unavailable resources. This was based on money, scope and time.	Project Triangle	Combine with and identify resources needed for game

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.3.5. Decide how resources will be used in the game	LP : No; CR: Partial; CA : Partial; SK : Partial	This step did not add any value to the SDM.		No
2.4. Security				
2.4.1. Identify game data that is sensitive	LP : Yes; CR: Yes; CA : Partial; SK : Partial	The data (on handheld device, server and network) that can be considered as sensitive in the location-based game was identified.		Combine into one phase.
2.4.2. Identify network packets that are sensitive	LP : No; CR: Yes; CA : Partial; SK : Partial	The teams included this step in previous steps.		No
2.4.3. Identify other security weaknesses	LP : Yes; CR: Yes; CA : Partial; SK : Partial	The teams did an analysis of possible attacks that could happen.		Yes
2.4.4. Choose valid action for weaknesses, data and network	LP : Yes ; CR: Yes; CA : Partial; SK : Partial	The teams identified counter measures against the attacks to be incorporated as part of the development process.		Yes
2.5. Initial game flow design				
2.5.1 Identify major cognitive process flows within the game	LP : Yes; CR: Yes; CA : Partial; SK : Partial	The teams developed an initial game flow from starting the game for the first time to being a recurring player.	Flow diagrams, screen mock-ups	Combine into one phase.

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.5.2. Develop storyboard for game flow	LP : Yes; CR: Yes; CA : Yes; SK : Yes	A storyboard was developed to roughly demonstrate the game flow, menus, leader board and in-game play workflow.		Yes
2.5.3. Determine game type and experience to navigate different process flows	LP : Yes; CR: No; CA : Yes; SK : Yes	This step allowed the teams to integrate all the workflows into one storyboard to gain a holistic overview of the game.		Yes
2.5.4. Revise storyboard to include in-game tutorial based on previous step	LP : No; CR: Yes ; CA : No; SK : No	The teams included this step in previous steps.		No
2.5.5. Develop first draft of aesthetic model	LP : No; CR: No; CA : Yes; SK : Yes	This step did not add any value to the SDM.		No
2.5.6. Present set of storyboards to testers	LP : Yes; CR: No; CA : Partial; SK : Partial	The testers were part of the development of the story-board and gave feedback as the storyboard was developed.		No
2.5.7. Present aesthetic model to testers	LP : No; CR: No; CA : Partial; SK : Partial	This step did not add any value to the SDM.		No

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
2.5.8. Modify storyboards to accommodate tester input	LP : Yes; CR: No; CA : Partial; SK : Partial	The entire team was part of the development of the storyboard.		No
Phase 3: Pre-design Phase				
3.1. Assemble team				
3.1.1. Identify specialists	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Identify if there are any other team members needed.		No
3.1.2. Identify organisational departments' involvement	LP : No; CR: No; CA : Partial; SK : no	The teams included this step in previous steps.		No
3.1.3. Identify specialists that need to work as pairs	LP : Yes; CR: Yes; CA : Yes; SK : yes	Used a specialist group flow diagram to indicate at which stage which specialists will work together.		Yes
3.2. Exploration				
3.2.1. Discuss requirements identified in new team	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Bring the new team members up to speed.		Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
3.2.2. Discuss needs of game in new team	LP : No; CR: No; CA : No; SK : Partial	This step did not add any value to the SDM.		No
3.2.3. Develop functional solution	LP : No; CR: No; CA : No; SK : Partial			No
3.3. Get identified team up to date	LP : No; CR: No; CA : No; SK : Partial			No
3.4. Plan ahead				
3.4.1. Plan for the next phases	LP : Yes; CR: Yes; CA : Partial; SK : yes	The teams identified how each of the following phases would be executed, as well as how they would keep track of work that was being done and what needed to be done. The teams also planned how the testing would be done and how the tuning plan would work.		Yes
3.4.2. Integrate previous and upcoming outputs	LP : No; CR: No; CA : Partial; SK : Partial	The teams included this step in previous steps.		No
Phase 4: Design Phase				
4.1. Game Identity				
4.1.1. Develop framework for game				Rename to: Design framework for game

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
4.1.1.1. Identify core programmer design	LP : Yes; CR: Yes; CA : Yes; SK : Yes	These steps helped the team to verify if the identified tools and techniques were the right fit for the development of their location-based game. If necessary, the tools and techniques were revised and refined to better fit the location-based game.		Yes
4.1.1.2. Identify graphics design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.1.3. Identify art design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.1.4. Identify network design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.1.5. Identify sound design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.1.6. Identify security design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.1.7. Identify AI design	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
4.1.2. Integrate design from different specialists	LP : No; CR: No; CA : No; SK : Partial	The design of the game framework included the entire team.		No
4.2. Analyse game framework with entire team	LP : No; CR: No; CA : No; SK : No	This step did not add any value to the SDM.		No

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
4.3. Design Planning	LP : No; CR: No; CA : No; SK : No	The teams included this step in previous steps.		No
4.3.1. Refine cost and design implications	LP : No; CR: No; CA : No; SK : No	These steps did not add any value to the SDM.		No
4.3.2. Determine different platforms for deploying game	LP : No; CR: No; CA : No; SK : No			No
4.3.3. Compile compatibility list	LP : No; CR: No; CA : No; SK : No			No
4.4. Design				
4.4.1. Implement logical design according to specifications	LP : Yes; CR: Yes; CA : Partial; SK : Yes	The teams used data and process diagrams to draw the location-based game on the workflow and storyboard.	Data and process flow diagrams	Yes
4.4.2. Implement physical design according to specifications	LP : No; CR: No; CA : No; SK : Partial	This step did not add any value to the SDM.		No
Phase 5: Development Phase				
5.1. Development Planning				

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
5.1.1. Identify standards	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Teams identified different programming standards to make the integration easy and the code more maintainable.		Yes
5.1.2. Identify development environment , tools and techniques	LP : No; CR: No; CA : Partial; SK : Partial	This step did not add any value to the SDM.		No
5.1.3. Identify implementation plan	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams identified continuous builds, as well as how integration and change management would work and what technologies to use. The teams also identified the implementation dates for the project as a rough estimate as the SDM promotes agile software development.		Rename to: Develop implementation plan
5.1.4. Identify integration plan	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams identified and developed the integration plan for their location-based games.		Yes
5.1.5. Identify development plan	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The development schedule was identified. The teams decided which part of the location-based game would be developed at what time in the process, as well as when certain parts of the location-based game would be developed together.		Rename to: Develop development plan
5.1.6. Develop integration plan based on development plan	LP : No; CR: No; CA : No; SK : Partial	This step did not add any value to the SDM.		No
5.2. Development				
5.2.1. Specialists develop prototype	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The development of the games was based on prototype development. Different prototypes from different specialists were integrated at different times or at the same time.		Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
5.2.1.1. Integrate test results from previous integrated prototype testing if there are any	LP : No; CR: No; CA : Partial; SK : Partial	These steps did not add any value to the SDM.		No
5.2.1.2. Develop new prototype for first iteration or develop new prototype based on the previous iteration	LP : No; CR: No; CA : Partial; SK : Partial			No
5.2.2. Paired integration				
5.2.2.1. Different team members team up to integrate developed prototypes to form one large integrated prototype	LP : Yes ; CR: Yes ; CA : Yes; SK : Yes	The prototypes were integrated with the main project. If it was necessary for different team members to integrate prototypes and then add this to the main project, this was also done.		Yes
5.2.3. Implement each integrated prototype	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams used continuous builds and source control software, such as GIT to implement integrated prototypes.		Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
5.2.3.1. Implement integrated prototype in test environment	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams used continuous builds and source control software, such as GIT to deploy the newest version of the location-based game to test the environment.		Yes
5.2.3.2. Hand integrated prototype over to testers	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Testers could test the environment to test the newest version of the location-based game.		Yes
Phase 6: Testing Phase				
6.1. Integrated testing	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Testers conducted regression testing to ensure that the newest integrated prototype did not add defects to the test environment.		Yes
6.1.2. Test each implementation of integrated prototype	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Testers tested new features added by integrated prototypes.		Yes
6.2. Alpha testing	LP : Yes; CR: Yes; CA : Yes; SK : Yes	When the location-based game was ready it was given to the alpha testers to play the game.		Yes
6.3. Beta testing	LP : Yes; CR: Yes; CA : Yes; SK : Yes	When the location-based game was ready it was given to the beta testers to play the game.		Yes
Phase 7: Tuning Phase				

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
7.1. Analyse problems identified in testing	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams used these phases to fix bugs in the code, issues raised by testers, and to change aspects that needed to be changed. This was then used to fix and tune the prototype that was developed and redeployed to the test environment.		Yes
7.2 Analyse tester or closed beta players' feedback	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3 Apply six aspects of playability and re-playability	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.1. Tuning based on social	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.2. Tuning based on completion	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.3. Tuning based on experience	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.4. Tuning based on challenging	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.5. Tuning based on mastery	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
7.3.6. Tuning based on impact	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
7.4. Re-design development plan	LP : No; CR: No; CA : No; SK : Partial	This step did not add any value to the SDM.		No
Phase 8: Pre-production Phase				
8.1. Marketing campaign (integrated in phases 1-8)				
8.1.1. Design game name	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams developed the game name before the actual development of the location-based game. This could change but it motivated the teams to have a name for their common goal.		Yes
8.1.2. Design game logo	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The logo for the location-based game was designed and had the same effect as the name.		Yes
8.1.3. Design marketing campaign	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams used strengths, opportunities, weaknesses and threats (SWOT) analysis to try to gain a competitive edge. Social media platforms, such as Facebook, Twitter, Instagram and Pinterest were used to start exposing the location-based game.		Yes
8.1.4. Develop game branding	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams developed the game branding and also preliminary merchandise for the location-based game.		Yes
8.2. Finalise game branding	LP : Partial; CR: No; CA : No; SK : No	These steps are not needed as the previous steps are a continuous process and do not need to be finalised.		No

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
8.3. Finalise game marketing campaign	LP : Partial; CR: No; CA : No; SK : No	These steps are not needed as the previous steps are a continuous process and do not need to be finalised.		No
8.4. Finalise tuning	LP : Partial; CR: No; CA : No; SK : No			No
Phase 9: Release Phase				
9.1. Support				
9.1.1. Set up support for the different platforms	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Teams used Facebook and Twitter to allow the players to launch complaints about the game. A website was also developed where the players could logon and use online support. Support flow diagrams were implemented to indicate the chain of support. A support tree was also implemented to show the different areas or issues, as well as how the support should be redirected to the appropriate specialist group.	Support flow diagram, support tree.	Yes
9.1.2. Set up support channels	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
9.1.3. Implement support communication channels	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
9.1.4. Implement support team	LP : Yes; CR: Yes; CA : Yes; SK : Yes			Yes
9.2. Pre-Release				
9.2.1. Ensure game is ready for deployment on all platforms	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Teams conducted regression testing on different platforms and versions of each platform.		Yes

Phases of the DMLBG	Completed	Process Followed	Extras Added	Keep as part of revised SDM
9.2.2. Ensure deployment for each platform market is understood	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Teams ensured that the game package that was going to be uploaded to various online stores was working and adhered to each of the online store's rules and regulations. Ensured that the game could be downloaded and installed on different devices.		Yes
9.3. Deploy game	LP : Yes; CR: Yes; CA : Yes; SK : Yes	Uploaded the location-based game to the various online stores.		Yes
Phase 10: Monitoring Phase				
10.1. Allow players to give feedback in-game	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams included this step in previous steps.		Yes
10.2. Set up different social media channels for player feedback	LP : Yes; CR: Yes; CA : Yes; SK : Yes	The teams included this step in previous steps.		Yes