

The use and effectiveness of systems development methodologies in developing electronic learning systems

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ABSTRACT

The main focus of this study is to determine if systems development methodologies are being utilised in the development of electronic learning systems in South Africa and if these methodologies are being applied effectively. Essentially this study can be viewed as exploratory research, utilising a conceptual research model to investigate the relationships between the constructs and measurements.

Electronic learning, or e-learning, is being employed to educate millions of learners, students and employees around the world and it is a critical component of modern educational systems. E-learning systems, or learning management systems, as it is known in the field, sit at the heart of these educational systems and are used to systematically deliver on-line content and facilitate the learning experience around that content. There is still much confusion and misconceptions surrounding e-learning and learning management systems abound. This study will try and clarify some of these misconceptions. In e-learning systems, the effective use of information systems is especially relevant as it is used to educate the minds of the future. To ensure that e-learning systems of outstanding quality are being developed, it is therefore crucial that systems development methodologies are being used as they can have a significant impact on the development process. There is a dearth of empirical research available on the use and effectiveness of systems development methodologies in South Africa. This study aims, amongst other things to make a contribution to the availability of empirical results.

By empirically evaluating the conceptual research model, utilising a survey as the main research method and statistically analysing the dataset, meaningful results were obtained. This study gave some insights into how learning management system procurement and development is being done in South Africa and revealed that the use of open-source systems currently exceeds the use of proprietary systems. The results of the research showed that systems development methodologies (e.g. Object-Oriented Analysis and Rapid Application Development) are being used effectively in the development of e-learning systems. Strong relationships exist between many of the systems development methodology factors identified (e.g. performance expectancy and the perceived support of the methodology) and the quality and productivity of the development process. This in turn has a strong influence on the impact systems development methodologies have on the quality of learning management systems.

Keywords: electronic learning, e-learning, learning management systems, systems development methodologies, effective, empirical, exploratory, survey, South Africa.

UITTREKSEL

Die hoofdoel van hierdie studie is om te bepaal of stelselontwikkelingsmetodologieë gebruik word in die ontwikkeling van elektroniese leerstelsels in Suid-Afrika en of hierdie metodologieë effektief benut word. Hierdie studie kan beskou word as verkennende navorsing wat 'n konsepnavorsingsmodel gebruik om verwantskappe tussen konstruksie en meetbare elemente te ondersoek.

Elektroniese leer, of e-leer, word gebruik om miljoene leerders, studente en werknemers, reg oor die wêreld op te lei. Dus is e-leer 'n kritiese komponent van moderne opvoedingstelsels. E-leerstelsels, of onderrigleerbestuurstelsels soos dit beter bekend staan, is die middelpunt van hierdie opvoedingstelsels en word gebruik om sistematies inhoud aanlyn te lewer en ook om die leerervaring te fasiliteer rondom hierdie inhoud. Daar is steeds baie verwarring en wanveronderstellings rondom e-leer en onderrigleerbestuurstelsels. Hierdie studie het ten doel om van hierdie wanveronderstellings uit te klaar. Met onderrigleerbestuurstelsels is die effektiewe gebruik van inligtingstelsels veral tersaaklik omdat hulle aangewend word om die jeug van vandag op te lei. Om te verseker dat e-leer stelsels van 'n hoogstaande gehalte ontwikkel word, is dit noodsaaklik dat stelselontwikkelingsmetodologieë effektief gebruik word omdat dit 'n beduidende invloed op die ontwikkelingsproses kan hê. Daar is 'n gebrek aan empiriese navorsing beskikbaar oor die gebruik en effektiwiteit van stelselontwikkelingsmetodologieë in Suid-Afrika. Hierdie studie wil onder andere ook 'n bydrae maak tot die beskikbaarheid van empiriese resultate.

Die konsepnavorsingsmodel is empiries geëvalueer deur gebruik te maak van 'n opname as die vernaamste navorsingsmetode en dan ook 'n statistiese analise van die datastel wat verkry is. Beduidende resultate is hierdeur verkry. Hierdie studie het lig gewerp op die manier waarop onderrigleerbestuurstelsels aangeskaf en ontwikkel word in Suid-Afrika en dit blyk of oopbronsels meer as kopieregstelsels gebruik word. Die resultate van die studie toon dat stelselontwikkelingsmetodologieë (soos objekgerigte programmering en snel-toepassings-ontwikkeling) effektief gebruik word in die ontwikkeling van onderrigleerbestuurstelsels. Sterk verwantskappe is gevind tussen die faktore (onder andere die prestasieverwagting en die waarneembare ondersteuning wat die metodologie verleen) en die gehalte en produktiwiteit van die ontwikkelingsproses. Dit het weer om die beurt 'n sterk invloed gehad op die impak wat stelselontwikkelingsmetodologieë op die gehalte van onderrigleerbestuurstelsels het.

Sleutelwoorde: elektroniese leer, e-leer, onderrigleerbestuurstelsels, effektiwiteit, empiriese, verkennende navorsing, stelselontwikkelingsmetodologieë, opname, Suid-Afrika.

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LIST OF ACRONYMS

ADL	Advanced Distributed Learning
CBSD	Component-Based Software Development
CEO	Chief Executive Officer
CMS	Content Management System
CSF	Critical Success Factor
ICT	Information and Communications Technologies
IE	Information Engineering
FDD	Feature Driven Development
ISD	Instructional Systems Design
LCMS	Learning Content Management System
LMS	Learning Management System
MLE	Managed Learning Environment
OOA	Object-Oriented Analysis
RAD	Rapid Application Development
RUP	Rational Unified Process
SCORM	Sharable Content Object Reference Model
SDLC	Systems Development Life Cycle
SDM	Systems Development Methodology
SSADM	Structured Systems Analysis and Design Methodology
SSM	Soft Systems Methodology
VLE	Virtual Learning Environment
XP	Extreme Programming

CHAPTER 1

RESEARCH PROBLEM

1.1. INTRODUCTION

To understand where we are going, we need to understand where we came from. Electronic learning, or e-learning, can trace back its roots to the early 1920's with Sydney Pressey's testing machine. Although it was designed for testing, it became associated with teaching as well. Programmed instruction (or programmed learning) came to be, as a result of Pressey's work in a linear approach to learning. Various ground-breaking studies were done on programmed instruction and educational technology throughout the 60's to 80s', which set the foundation for what we know today as e-learning (Holmes & Gardner, 2006).

Garrison and Anderson (2003) state that personal computing became a reality in the mid-1980's and that, together with accessibility to the Internet is "transforming teaching and learning". Many of the so called e-learning technologies are still in their infancy and we are only now beginning to understand how it will change the future of learning. We live in a technology-driven world, where everything changes at a feverish pace. Many of our daily activities are technology-based and for most of us it is important to at least be familiar with technology. Learning about technology and using technology to learn, goes hand in hand.

There are many reasons why e-learning is the current buzzword, and not least of all being the rapid expansion of the Internet. Advances in information and communication technologies (ICT) have made huge volumes of information available to millions of people around the world. Some reports suggest that the U.S. workforce spends well in excess of \$100 billion a year on job training (Clark & Meyer, 2008). In the early years of e-learning it has even been called the next "killer application" for the Internet, by the then CEO of Cisco Systems (Chambers, as cited in Henry, 2001).

Holmes and Gardner (2006) are of the opinion that e-learning is a critical part in educational systems around the world and some of the reasons for it being so popular are "the globalisation of commerce and citizenship" and the proliferation in the availability of information and knowledge on the Internet.

The incredible growth of the Internet¹ over the last 18 years is well documented and as a result of this rapid growth, vast quantities of information and resources became available. Garrison (2011) believes it is of the utmost importance that higher educational institutions need to understand and embrace the increasing importance of technology in an educational environment. It is obvious that our way of learning will have to adapt to this inundation of information.

If e-learning is applied efficiently, it can go a long way towards helping learners to generate and obtain knowledge for themselves.

1.2. RESEARCH PROBLEM

According to Holmes and Gardner (2006) e-learning has properties that can overcome certain limitations of traditional learning, specifically limitations regarding the set times and locations for learning. However, e-learning is still considered by most as only an add-on technology, compared to key developments in the ICT field.

With the dramatic increase in the popularity and use of e-learning and e-learning systems it becomes a necessity to ensure that systems of a high quality are being developed. As e-learning is becoming ever more popular, it has almost become synonymous with education. It is being used in universities for educational purposes, by corporations to train their staff, in primary and secondary schools to teach learners, etc. Almost all forms of training and education done nowadays, have an e-learning component.

More traditional methods of education have evolved over centuries and considerable time and effort have gone into developing the teaching methods being used to today. Our schools and tertiary institutions are using e-learning in a rapidly increasing manner. E-learning has only recently been introduced and has had far less time to evolve into the tried and tested methods of learning. Many cultures around the world still have no access to even basic education. E-learning can be one of the answers to this problem.

As with all things nowadays and even more so in the technology sector, the rate of growth and development is quite rapid. Developers of e-learning systems are being faced with various problems, one being: *how exactly to apply technology in the learning process*. Even a cursory study into e-learning makes it clear that there is still plenty of confusion surrounding e-learning and the technology and applications involved with it.

¹ From 16 million users in December, 1995 to 2,749 million users in March 2013 (Internet World Stats, 2013).

It becomes apparent there is still much to benefit, from further research into this field.

In another and not unrelated field of Systems Development Methodologies (SDMs), much more research has been done and the value of SDMs is proven and documented. However, there is still a lack of empirical evidence on the actual use and effectiveness of SDMs and even more so with its use and effectiveness in the development of e-learning systems. SDMs have had a major impact on the development of software systems over the last 40 odd years and are an indispensable tool for developing systems in recent times.

E-learning systems, being an emerging subset in software systems technology, could well profit from the benefits SDMs have to offer.

1.3. RESEARCH AIM AND OBJECTIVES

The aim of this study will be to research the use and effectiveness of SDMs in the development of e-learning systems.

The objectives can be summarised by asking the following questions that this study will try and answer:

- i. Are SDMs currently being used in developing e-learning systems?
- ii. If so, which SDMs are being used?
- iii. Are the SDMs being used effectively?
- iv. Is there a difference between the SDMs used for proprietary and open-source systems?
- v. How can a specific SDM be adapted to better suit e-learning systems?
- vi. Can an SDM be developed to promote the chances of success for developing e-learning systems?

1.4. POSSIBLE CONTRIBUTIONS OF THE STUDY

This study will possibly shed some light on what the South African e-learning market looks like. The researchers aim to get a holistic picture of how e-learning systems (or more specifically, learning management systems) are being procured or developed in South Africa. The reason for this is twofold, specifically to determine if open-source learning management systems are gaining ground on their proprietary counterparts and also to determine relationships between the type of industry and the learning management platform.

There are still many unknowns when it comes to e-learning systems. The researchers will try and clarify these and provide a working knowledge on e-learning systems.

Another contribution will be to determine if systems development methodologies are being utilised in the development of e-learning systems and to what extent these methodologies are being applied. There is a dearth of empirical research available on the use and effectiveness of systems development methodologies. Although this study will only try and contribute to the empirical evidence of these as pertaining to e-learning systems, this will nonetheless be a commendable contribution if conducted effectively.

With the abovementioned knowledge in hand, one can try and determine possible relationships between the quality of e-learning systems and the manner in which they were developed.

The ultimate aim will be to contribute to the acceptable body of knowledge as to how systems development methodologies can be utilised to the betterment of e-learning systems.

1.5. OUTLINE OF THE STUDY

The study has seven chapters and will be organised as follows:

Chapter 1: Research problem

In this chapter the background will be introduced and the research problem will be stated. The research aim and objectives, as well as the expected contribution of the study, will be revealed. The chapter will be concluded by an outline of the study.

Chapter 2: Research design

This chapter will provide a research plan for this study by discussing the various types of data, the generation and analysis methods thereof, giving an overview of research paradigms and strategies and touching on statistical analysis.

Chapter 3: Literature study: Electronic learning

This chapter will review the literature on electronic learning and electronic learning systems. A working knowledge on learning management systems, e-learning objects and standards and the critical success factors of e-learning will be provided.

Chapter 4: Literature study: Systems development methodologies

This chapter will review the literature and give a brief overview of systems development methodologies, as well as discuss the use and effectiveness of SDMs. Web-based SDMs and instructional design systems will also be addressed.

Chapter 5: Questionnaire design and conceptual research model

This chapter will elaborate on the research design in Chapter 2 and will specifically discuss the measurement instrument of questionnaires. It will also sketch a conceptual research model based on the research objectives.

Chapter 6: Results of the statistical analyses

This chapter will provide the results of the statistical analyses that were carried out on the data gathered from the survey.

Chapter 7: Conclusion and final comments

This chapter will highlight the findings of this study, recommend possible future research and conclude the study.

In the next chapter, the research design will be discussed.

CHAPTER 2

RESEARCH DESIGN

2.1. INTRODUCTION

Research is characterised by Olivier (2009) as an investigation to discover facts with the aim of extending the accepted body of knowledge.

To reach this goal, one has to conduct research in a meticulous and methodical way, by using a suitable research method and thereby ensuring reliability and credibility.

This chapter will provide a research plan for this study by discussing the various types of data, the generation and analysis methods thereof, by giving an overview of research paradigms and strategies and touching on statistical analysis of the data generated.

Myers and Avison (2002) state that research methods can be classified in various ways, with the distinction between quantitative and qualitative data, being one of the more common ones. This study will also use this distinction.

2.2. QUANTITATIVE DATA ANALYSIS VS. QUALITATIVE DATA ANALYSIS

Before one can decide on which philosophical paradigm to conduct one's research in, it is important to differentiate between quantitative and qualitative data, and the analysis thereof.

Knowing the characteristics of the different data types and analysis strategies associated with them, will guide one in the choice of which research paradigm to conduct one's research in.

Just as the different philosophical paradigms of research determine the research strategy to be used, and in turn determine the data generation method that will likely produce the best results, so does the data generation method determine what type of data will be generated. The methods of analysis are largely dependent on the type of data that was produced.

This section will describe the different types of data and what underlying paradigm they are best suited for.

2.2.1. QUANTITATIVE DATA ANALYSIS

Quantitative data is data that is based on numbers and is mainly generated by experiments and surveys. This type of data are mostly used and analysed by researchers in the positivistic paradigm.

According to Oates (2006), quantitative data analysis involves looking for patterns in the data and drawing conclusions. There are various analysis techniques available for the analysis of different types of data, and therefore it is of importance to differentiate between the types of quantitative data:

- **Nominal data** describes categories and not a definite numeric value. That is to say, the number only represents a category and in itself is meaningless. For example, 1 for male, 2 for female.
- **Ordinal data** is data that have numbers allocated to a quantitative scale. Arithmetical operations are possible, as there is an order to the designated code numbers. For example, “Applicable”, “Neutral” and “Not applicable” may be coded as numbers 1 to 3.
- **Interval data** is data that have numbers allocated to a quantitative scale, where the intervals between the points on the scale are consistently the same size, or proportionate to each other. For example, the difference, or interval, between ages 20 and 25 is the same as the interval between 30 and 35.
- **Ratio data** is data that have numbers allocated to a quantitative scale, where the intervals between the points on the scale are consistently the same size, with a true zero to the measurement scale. Therefore, basic arithmetic operations, addition, subtraction, multiplication, and division, can be applied. For example, one's salary can be 0, the passing rate of a group of students can be 0, etc.

One can also make a distinction between two other data categories, namely discrete data and continuous data. With discrete data, each number can only be a whole number and only have a finite number of possible values, whereas continuous data makes up the rest of the numbers, i.e. the fractions between the whole numbers.

According to Oates (2006), after you have generated the needed data, it must be prepared for quantitative analysis. This preparation is called *data coding* and basically means that all the data have to be in a numeric form, for one to carry out quantitative analysis on it.

The data is now ready to be quantitatively analysed using visual aids, for example, tables, charts, graphs, or by using statistics. More will be mentioned about statistical analysis in section 2.6.

The final step in quantitative data analysis is the interpretation of the results. This will be done in Chapter 7 of this study.

It becomes clear that quantitative data analysis best belongs to the positivistic paradigm and thus will be the means of collecting and analysing data for this study.

2.2.2. QUALITATIVE DATA ANALYSIS

Qualitative data includes all non-numeric data, such as words, images, sounds and so forth, and is mainly generated by case studies, action research and ethnography. This type of data is mostly used and analysed by researchers in the interpretive paradigm.

It is possible to use quantitative data analysis on qualitative data; however, most qualitative data involves abstracting the verbal, visual or aural aspects from the research data. Qualitative data have the Achilles' heel of not having steadfast rules and procedures of how to go about such research and it often depends on the experience and ability of the researchers to analyse this type of data effectively (Oates, 2006).

2.3. RESEARCH PARADIGMS

All research has certain underlying principles that guide and direct the research process. Research can be defined as the creation of new knowledge and is, according to Myers and Avison (2002) and Oates (2006), driven by one of three categorically different philosophical paradigms, namely: positivism, interpretivism and critical research. A paradigm, in turn, is a shared way of thinking, shared assumptions, underlying intellectual structure, common practices and in general a similar approach of doing and reasoning about things (Oates, 2006; Kuhn, 1996).

At this point the concepts of ontology and epistemology can be introduced as they are generally considered the cornerstones of research. Ontology pertains to philosophical beliefs (in other words, assumptions) regarding physical and social reality. Epistemology, in turn, is concerned with beliefs relating to knowledge; thus, how an individual comprehends the world and communicates this knowledge (Punch, 1998). The reason one has to clarify these concepts is that each of the paradigms has a different view concerning the nature of the

world (ontology) and how to gain and communicate knowledge (epistemology), in this regard.

It is important to understand the epistemological viewpoint of any research and as such the philosophical paradigms of positivism, interpretivism and critical research will subsequently be discussed.

2.3.1. POSITIVISM

Positivism underlies *the scientific method*, the approach to doing research in the field of natural sciences, and has two basic assumptions, namely: that the world is ordered, thus not random and that researchers can investigate it objectively (Oates, 2006; Gauch, 2003). The facts are also clearly defined and the results measurable (Burke, 2007).

The ultimate goal of the scientific method, and positivism, is to find universal laws, patterns and regularities, which is mostly done by experimenting, but can also be done with surveys. A positivist researcher should aim to prove or disprove the hypothesis (Oates, 2006).

Lee (1999) argues that research done in the natural sciences complies with three sets of rules, maintained by the natural science model. These rules are the rules of formal logic, rules of experimental and quasi-experimental design and the rules of hypothetico-deductive logic, which is the method of attempting to falsify a proposed hypothesis.

Oates (2006) and Gauch (2003) describe three techniques of the scientific method:

- Reductionism, meaning to break complex things into smaller things.
- Repeatability, in which researchers do not rely on the results of only one experiment.
- Refutation, where if other researchers cannot repeat an experiment with the same results, they can refute (or disprove) the hypothesis.

The collective worldview of researchers in the paradigm of positivism, as outlined by Oates (2006) and Myers and Avison (2002), will subsequently be summarised:

- The world exists independently of humans.
- Researchers discover this world by means of observations, measurements and producing models.
- Researchers are able to remain impartial to the subject being studied and thus conduct the research objectively and free from personal beliefs.
- Empirical testing of hypotheses provides the basis for research done in the positivist paradigm and results in the verification or refutation of a hypothesis.

- Quantitative data analysis, such as mathematical modelling and statistical analysis, is the preferred method for analysing the data generated.
- Research looks for universal laws, patterns or irrefutable facts, collectively called generalisations.

Epistemologically², positivism recognises only two forms of knowledge as actual knowledge, namely: empirical (represented by natural sciences) and logical (represented by logic and mathematics) knowledge (Hughes, 1990).

To conclude, positivistic research is scientific and objective and focuses on logic, reckoning and facts to prove or disprove a hypothesis.

2.3.2. INTERPRETIVISM

In contrast to positivism, that tries to confirm or refute a hypothesis, interpretivism aims to discover how all the factors in a particular social framework are related but also interdependent. Research done in this paradigm tries to identify these factors, and to explore and explain them. The aim, ultimately, is to understand how humans perceive this possibly unique world or setting they find themselves in (Oates 2006).

Myers and Avison (2002) state that researchers assume that access to reality can only be obtained through social constructions, such as language, consciousness and shared meanings.

As with positivism, there is also a shared view of what defines interpretivism and the following characteristics are outlined by Oates (2006):

- There is more than one subjective reality and what we perceive to be real or true is only a product of our minds.
- Reality can only be transferred to another person by language, shared meanings and understanding.
- The beliefs, assumptions, values and actions will ultimately determine the research process and influence the situation; thus, it can be said that researchers in this paradigm are not neutral.
- Research is aimed at studying and understanding people in their natural social settings and not in an artificial environment, where most experiments take place.

² Epistemology refers to beliefs concerning knowledge and how we understand the world and communicate this knowledge (Punch, 1998).

- There is a strong focus on generating and analysing qualitative data, that is to say non-numeric data, such as words, images, sounds, etc.
- Researchers expect to arrive at multiple interpretations and explanations and will discuss the one that can be proven more strongly.

Interpretivism can be described as research, where the researcher self, is an instrument for observation, selection and interpretation (Lee, 1999).

Therefore, interpretive research is done to develop a hypothesis, in which case the hypothesis is the end result.

2.3.3. CRITICAL RESEARCH

Oates (2006) defines critical research as research that is concerned with identifying power relations, conflicts and contradictions with the aim of empowering people. Oates (2006) goes further by saying that researchers in the critical research paradigm, share a common belief with researchers in the interpretive paradigm, namely that social reality is created by people, but this social reality also has objective properties that will dominate how we perceive the world.

Howcroft and Trauth (2004) have identified five common themes associated with critical research:

- Researchers in the critical research paradigm are committed to empowering people and liberating them from the power relations of society and organisations.
- Critical researchers question and challenge the status quo and the existing patterns of power are confronted.
- Research in this paradigm has a non-performative intent, that is to say projects are not undertaken to improve managerial processes and efficiency.
- Critical researchers do not believe that technology determines how our world is shaped, but rather that people and society drive how technology is developed.
- Objective knowledge is questioned and a belief exists that areas of knowledge and development are often shaped by those with power.

Kincheloe and McLaren (2002) argue that critical research cannot easily be defined, as there are multiple critical theories and also that critical tradition changes constantly. This is research that focuses on the matter of power within an organisation, and the various ways that economy, race, social class, gender, ideologies, education, religion and cultural

dynamics work collectively, to form a social system. Kincheloe and McLaren (2002) consider the interpretation of information to be the most important aspect of research in this paradigm. Critical research thus has the objective to deliver social critique and tries to eliminate the causes of domination and alienation.

2.3.4. RESEARCH PARADIGM USED IN THIS STUDY

This study will be done in the paradigm of positivism, as the nature of the research problem lends itself naturally to a positivistic approach.

The aim will be to quantify the influence, or lack there-of, that systems development methodologies have on e-learning systems and to objectively try and proof or disproof, this supposed influence.

2.4. RESEARCH STRATEGIES ASSOCIATED WITH THE POSITIVISTIC PARADIGM

Generally, certain research strategies are more suited to research done in a specific paradigm. These methods were originally developed in the natural sciences to study natural phenomena (Myers & Avison, 2002). This section will discuss three research strategies associated with positivism, as related to this study, and how they are conducive to research being done in this specific paradigm.

2.4.1. SURVEYS

Since surveys look for patterns and generalisations in data, it is mostly used in the philosophical paradigm of positivism, but in certain cases it can be used in interpretivism and in critical research.

Surveys generalise data by targeting a relatively small group of a larger population and drawing conclusions based on the results (Oates, 2006). Data generation methods used with surveys include questionnaires, interviews, observations and documents.

In the field of information systems surveys are a popular strategy to employ in the collection of empirical³ evidence.

³ Empirical means: based on, concerned with, or verifiable by observation or experience rather than theory or pure logic (Merriam-Webster, 2013).

Some of the advantages of surveys, according to (Oates, 2006), will be briefly mentioned:

- By targeting a relatively small representative sample, conclusions on a wider population can be made.
- Large amounts of data can be produced in a reasonably short time.
- As surveys produce quantitative data, this type of analysis can also be done.
- Researchers that may lack good personal and communication skills prefer to use this research strategy.

Some of the disadvantages of surveys, according to (Oates, 2006) will be briefly mentioned:

- Rather than focussing on detail, surveys tend to focus on width.
- Certain aspects of a research subject cannot be expressed in numbers and can therefore be overlooked.
- Surveys can only show associations and not cause and effect.
- With certain types of surveys, for example Internet-based questionnaires, it is not possible to judge the honesty of people's responses.

2.4.2. EXPERIMENTS

Experiments are strongly associated with the scientific method of doing research, and are thus linked to the positivist paradigm.

Oates (2006) states that an experiment is specifically designed to prove or disprove a hypothesis, and that any factors that can affect the outcome of an experiment are excluded from the study. Oates (2006) and Srinagesh (2006) list the characteristics of experiments as:

- Researchers making use of this strategy will observe and measure outcomes and changes that may occur when a certain factor is introduced.
- Manipulation of circumstances follows observation and measurement.
- The aim of experiments is to prove or refute a possible relationship between two or more factors.
- Researchers try to identify causal factors.
- The casual link between two factors is explained by means of a theory and will be able to predict future events if the hypothesis is proved.
- Experiments are repeated several times to be certain of the results obtained by the causal factor.

2.4.3. CASE STUDIES

Case studies focus on one instance of the research subject and study this case in depth. Any of the three philosophical paradigms can use case studies as a research strategy.

The characteristics of case studies, as outlined by Oates (2006) and Gillham (2000) are:

- Researchers focus on detail and depth when investigating the specific instance of a case.
- The case is not examined in artificial conditions but in its natural environment.
- Researchers look at the greater picture with a holistic approach to studying the subject.
- Case studies can produce either quantitative or qualitative data by using a wide range of data generation methods.

2.4.4. RESEARCH STRATEGY USED IN THIS STUDY

This study will make use of surveys as a research strategy as it lends itself well to the subject being studied. If used correctly, the data generated will be in quantitative format with the minimum data coding needed. By targeting a relatively small group of people who will be representative of a much larger population, statistics can be surmised and conclusions drawn from the data.

2.5. DATA GENERATION METHODS

There are various data generation methods available to use with all the different research strategies. Some are better suited for a specific strategy than others.

The data generation methods that will be mentioned include interviews, questionnaires and documents.

2.5.1. INTERVIEWS

According to Oates (2006) and Monahan (2004), interviews are a specific kind of conversation between people with set assumptions, including:

- One of the parties usually wants to gain information from the other party(s) involved, which entails that the conversation does not take place by chance.

- The topics up for discussion are usually predetermined and are guided by the researcher.
- An interview is an open meeting aimed at producing research material.
- If not specifically stated, any information is available to the researcher and seen as “on the record”.

Interviews are widely used in case studies and ethnographies but can also be used in surveys if the researcher follows a closed and structured interview approach.

2.5.2. QUESTIONNAIRES

As previously mentioned, questionnaires are mainly associated with surveys, as research strategy and are defined by Oates (2006) and Cohen, *et al.* (2011) as a pre-defined set of questions, which is arranged in a pre-defined order. These questionnaires have to be completed by respondents, in order to provide the researcher with data that can be analysed and interpreted.

The researcher looks for patterns so that generalisations about a larger population can be made (Newsted *et al.*, 1998).

Questionnaires can either be self-administered, that is, the respondent completes the questionnaire without the presence of the researcher, or researcher-administered, that is, with the involvement of the researcher.

Oates (2006), Newsted *et al.* (1998) and Jack and Clarke (1998) give the following reasons why researchers use questionnaires so often:

- It is a cost-effective method of collecting data from large numbers of the population.
- It lends itself to obtaining information that is relatively brief and uncontroversial.
- It provides the researcher with standardised data by asking people to complete an identical set of questions.
- The researcher will use questionnaires in situations where the respondents will be able to comprehend the questions and answers.
- The time allowed to wait for the return of responses is adequate.

Dillman (2011) believes that respondents are more relaxed when completing self-administered questionnaires, thus eliminating interviewer bias.

On the other hand, the response rate could be low when using questionnaires as data generation method (Siau & Rossi, 1998).

2.5.3. DOCUMENTS

Documents are another source of data and can be divided into, found documents and researcher-generated documents. Found documents are in existence before the research began and can be found in most organisations, while researcher-generated documents are created for the sole purpose of the research (Oates, 2006).

2.5.4. DATA GENERATION METHOD USED IN THIS STUDY

Questionnaires will be used to generate data for this study. It is a popular method for generating data in the field of information systems and one can generalise data by targeting a relatively small group that is representative of a larger population. In Chapter 5 of this study, we will elaborate on questionnaires as data generation method.

2.6. USING STATISTICS FOR QUANTITATIVE DATA ANALYSIS

According to Oates (2006) and Feldman *et al.* (1998), statistical techniques differ from using tables and charts for organising empirical data, in that it offers a universal means and criteria for evaluating key points and making generalised conclusions based on the evidence. Firstly, in this section, certain selected statistical concepts and techniques will be discussed, followed by a description of factor analysis and the statistical methods that will be applied to the data.

2.6.1. DESCRIBING THE CENTRAL TENDENCY OF DATA

According to Oates (2006) and LeBlanc (2004), there are three statistical measures that describe the central tendency of the data:

- The mean or the average.
- The median or midpoint.
- The mode or most common value.

2.6.2. THE DISTRIBUTION OF VALUES IN A DATASET

Oates (2006) refers to three statistical techniques to describe the distribution of the values in a dataset:

- Range describes the difference between the highest and lowest value.
- Fractiles to divide the data spread in smaller parts.

- Standard deviation to measure the average distance of each value from the mean.

2.6.3. CORRELATION COEFFICIENTS

According to Thomas (1989) and Oates (2006), correlation coefficients are calculated to determine the linear relationship between two variables. The result of a correlation coefficient is a value between -1 and +1.

Assumptions that can be made from this value are:

- A positive value: There exists a positive linear relationship between the variables.
- A negative value: There exists a negative linear relationship between the variables.
- A zero value: There is no relationship between the variables.
- Any value between 0.3 and 0.7 means there is a relatively strong relationship between the variables.
- The closer the value gets to 1, the stronger the relationship between the variables.

2.6.4. NULL HYPOTHESIS AND TESTS OF SIGNIFICANCE

LeBlanc (2004) and Oates (2006) state that researchers start with the null hypothesis when testing a relationship between variables. They assume that there is no relationship between variables. Statistical tests of significance are done to estimate the likelihood that the relationship is purely accidental. A relationship is regarded as statistical significant if the probability of such a relationship occurring by chance is less than 1 in 20. Statistical significance is indicated by a *p value* and thus if $p \leq 0.05$ (1/20) the relationship is statistically significant (See Table 2.1). This interpretation will be used in the rest of the study.

Depiction	<i>p value</i>	Significance
'	≤ 0.10	Noteworthy
*	≤ 0.05	Moderate relationship
**	≤ 0.01	Strong relationship
***	≤ 0.001	Very strong relationship

Table 2.1: Interpretation of level of significance

2.6.5. CROSS-CLASSIFICATION TABLE

The cross-classification table (crosstab) analysis is used to study the relationship between two or more categorical variables (Goodman, 1985).

2.6.6. FACTOR ANALYSIS

It is possible that answers to different questions in a questionnaire are driven by a few underlying and unobserved variables, called factors. With the use of factor analysis one can determine which variables form sub-collections, and which are relatively independent from one another (Tabachnick & Fidell, 2001).

In this way factor analysis is being done to group variables with high inter-correlations in order to identify factors that describe a group of variables, and to reduce the amount of variables to a smaller number of factors (Field, 2005).

2.6.7. T-TESTS

T-tests are one of the most widely used statistical tests and can be adapted to suit an expansive range of situations (Lowry, 1999).

In cases where one wants to compare two sets of data to determine if there is a significant difference between them, t-tests work well. The null hypothesis will state that there is no significant difference between the means of two groups (Oates, 2006).

This type of test can be used with a small sample, which is ideal for this study.

For this study the researchers will use a combination of the abovementioned techniques to describe the data and to determine the existence of certain factors. T-tests, crosstabs and nonparametric correlations will be used to determine possible relationships between the variables and factors.

2.7. RESEARCH PLAN

The aim of this study is to quantify the influence, or lack thereof, that Systems Development Methodologies has on e-learning systems and to prove or disprove this supposed influence.

After the initial literature review on research methods is done, one can develop a research plan. In this section the research plan, for tackling the research problem, will be outlined.

2.7.1. STEPS IN THE RESEARCH PLAN

This section will highlight the steps that will be followed in conducting this research.

2.7.1.1. LITERATURE STUDY

Firstly, a literature review will be done on e-learning in general, followed by a more in-depth focus on defining e-learning and e-learning systems. The purpose of the literature review will be to sketch a holistic picture of e-learning and to determine what factors have an influence on the success of e-learning systems.

Secondly, a literature review will be done on Systems Development Methodologies in order to introduce the concept of SDMs, with the purpose as to eventually determine the influence, or lack thereof, on e-learning systems.

2.7.1.2. DATA GENERATION

To prove or disprove that SDMs have an influence on e-learning systems, one needs to collect data from the relevant industries, in an effort to get a dataset representative of the population.

This study will use surveys as research strategy and specifically questionnaires as the method for generating data. Surveys look for patterns and generalisations in data and will be a good fit for this type of research.

2.7.1.3. DATA ANALYSIS

As discussed in this chapter, surveys will generate quantitative data and analysis therefore will be done quantitatively, by using statistical analysis techniques, such as factor analysis, t-tests and crosstabs.

In Chapter 6 (section 6.2) the descriptive statistical analysis of the study population will be presented. This will include the background information of respondents, such as the industry

in which they work, the size of the LMS, etc. Chapter 6 (section 6.3) of this study will present the inferential statistical analysis. This section will look at possible relationships between the variables and factors in an attempt to answer the research questions set in Chapter 1 (section 1.3). According to Oates (2006) it will not suffice to only do statistical analysis. One has to interpret and evaluate the results as well. This will be done in Chapter 7.

2.8. CONCLUSION

In this chapter, a distinction between the different types of data and the methods for generating and analysis thereof, were drawn. Research paradigms, as a guide to conducting research in a specific domain, were discussed. It was decided that the positivistic paradigm was most favourable for research in the field of information systems and our specific research problem. The research paradigm determines the research strategy, in this case surveys, which will be most conducive to the study. The data generation method of questionnaires was decided on, which will lead to quantitative data being collected and quantitative data analysis that will be applied to interpret the results.

This chapter also outlined the steps that will be followed in the research process, thus providing a research plan and framework that will guide the study.

In the next chapter, the literature review on e-learning and e-learning systems will be discussed.

CHAPTER 3

ELECTRONIC LEARNING

3.1. INTRODUCTION

This chapter gives a background on what is implied by the term e-learning (section 3.2), draws a distinction between the different types of e-learning (section 3.3), discusses the environment in which e-learning functions (section 3.4), gives a clarification of some of the misconceptions that exist (section 3.5), confers the difference between open-source and proprietary e-learning systems (section 3.6), mentions e-learning objects and standards (section 3.7), lists the advantages and disadvantages of e-learning (section 3.8), discusses some of the pitfalls and opportunities inherent to e-learning (section 3.9) and ends with discoursing the critical success factors of e-learning (section 3.10).

3.2. DEFINITION OF E-LEARNING

Over the last decade or so, there has been some contention over the exact definition of e-learning and the terminology associated with e-learning. Some authors see e-learning as an overarching activity that involves any type of learning that is supported by ICT. This overarching term has been referred to as educational technology, communication and information technologies, technology-enhanced learning or web-based training.

Some of the more noteworthy definitions of e-learning include:

- According to Conole and Oliver (2007), e-learning is the term most commonly used to represent the broader domain of development and research activities on the application of technologies to education. In this definition the broad range of activities refers to ICT.
- The American Society for Training and Development (ASTD) defines e-learning as a broad set of applications and processes, which include web-based learning, computer-based learning, virtual classrooms, and digital media.
- Instruction delivered via a computer that is intended to promote learning (Clark & Mayer, 2003).
- Holmes and Gardner (2006) simply define e-learning as “on-line access to learning resources, anywhere and anytime”.

For the purposes of this study e-learning can be seen as a medium for delivering and facilitating learning, through electronic means.

3.3. TYPES OF E-LEARNING AND BLENDED E-LEARNING

In this section the different types of e-learning pertaining to this study will be mentioned, in order to provide a foundation to work from.

There are different types and applications of e-learning to address the various styles of learning (Bruen & Conlan, 2002).

Broadbent (2002) suggested that one can categorise e-learning into four types, namely: informal, self-paced, leader-led and through performance-support tools. In informal e-learning, a learner could access a website or join an on-line discussion group to find relevant information. Self-paced e-learning, on the other hand, refers to the process whereby learners' access computer based or web-based training materials, at their own pace. Instructor-led or leader-led e-learning, as the name suggests, refers to an instructor, tutor or facilitator leading the process. This type of e-learning can be divided into two categories, namely: asynchronous learning and synchronous learning (Lovelace 1999).

3.3.1. ASYNCHRONOUS VS. SYNCHRONOUS E-LEARNING

For this study a distinction will be drawn between asynchronous or self-paced learning and synchronous or instructor-led e-learning

Asynchronous e-learning is facilitated by email, discussion boards, forums etc. Learners can log onto an e-learning environment, at will, and the learner is generally responsible for his/her own progress. Synchronous e-learning is facilitated by face-to-face session or videoconferencing and chat, and can be seen as more social. It is often used in the development of "learning communities" (Hrastinksi, 2008). This type of e-learning can be described as the use of performance-support tools, which refer to material that learners can use to help them perform a task (normally in software).

The reason one has to draw a comparison between asynchronous and synchronous e-learning is to understand that both offer distinct advantages and when used together, can have significant complementary effects.

In Table 3.1, the properties of these two learning sub-types, as surmised from Hrastinksi (2008), are listed.

	Asynchronous e-learning	Synchronous e-learning
When?	<ul style="list-style-type: none"> ▪ Reflecting on complex issues. ▪ When synchronous meetings cannot be scheduled due to work, family etc. 	<ul style="list-style-type: none"> ▪ Discussing less complex issues. ▪ Getting acquainted ▪ Planning tasks
Why?	<ul style="list-style-type: none"> ▪ Students have more time to reflect since sender does not expect an immediate answer. 	<ul style="list-style-type: none"> ▪ Students become more committed and motivated when quick response is expected.
How?	<ul style="list-style-type: none"> ▪ E-mail, discussion boards, forums, blogs. 	<ul style="list-style-type: none"> ▪ Video conferencing, instant messaging, face-to-face meetings.
Example	<ul style="list-style-type: none"> ▪ Students reflect individually on course topics. 	<ul style="list-style-type: none"> ▪ Students expected to work in groups may be advised to use instant messaging to exchange ideas, etc.

Table 3.1: Properties of asynchronous and synchronous e-learning (Hrastinksi, 2008)

3.3.2. BLENDED E-LEARNING

The concept of blended e-learning can also be introduced at this time. Littlejohn and Pegler (2007) state that the art of blended learning has been practised by teachers for centuries. It basically entails the integration of different types of resources and activities within a learning environment, where interaction between learners and the exchange of ideas are promoted.

Blended e-learning can thus be defined as the blending of e-learning, with traditional teaching methods.

3.4. E-LEARNING SYSTEMS

As with many aspects in life, it pays to follow a systematic approach. It is no different with e-learning. The term systems approach can be defined as a holistic and analytical approach to solving complex problems (Schwalbe, 2010).

The Oxford dictionary (2013) defines a system as “A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole, composed of parts in an orderly arrangement according to some scheme or plan.”

A software system helps manage all the different technologies, concepts and aspects pertaining to a specific problem.

At this point the concept of Virtual Learning Environments (VLEs) will be introduced. The Joint Information Systems Committee defines the term VLE as the components in which learners and tutors participate in on-line interactions of various kinds, including on-line learning (As quoted in Weller, 2007).

VLEs can be described, in layman’s terms, as software systems that are specifically developed to facilitate teaching and learning in an educational environment. There seem to be a certain degree of hostility and objections to the term *virtual* as this is directly opposite to *real* and it is being implied that the learning being done is of a poorer standard, even if this is not the case (Weller, 2007).

From this, one can understand why the term is not as widely used as some of the synonyms of VLEs, but is mentioned as a precursor, for what we know today as Learning Management Systems (LMSs). Even more synonyms for VLEs and LMSs include: Content Management System (CMS), Learning Content Management System (LCMS), Learning Support System (LSS), Online Learning Centre (OLC), Open Courseware (OCW), or Learning Platform (LP); it is education via computer-mediated communication (CMC) or Online Education.

The term Learning Management System is the most widely used, and will also be used for the purposes of this study.

Weller (2007) states that even the well-known and widely acceptable term, LMS, “causes consternation” with some educationalists, because of the suggestion that it manages the student’s learning in a very direct manner, which is contradictory to the more “exploratory, constructivist teaching approaches”, that e-learning promises.

Paulsen (2002) defines an LMS as a broad term that is used for a wide range of systems that organise and provide access to on-line learning services for students, teachers and administrators.

Ryan Ellis, who is the editor of *Learning Circuits*, defines LMS as a software application that automates the administration, tracking and reporting of training events (Ellis, 2009).

It becomes quite clear that, as with the definition of e-learning, the same amount of confusion, surrounding the exact meaning of e-learning systems, exists.

The definition Weller (2007) provides, best explains an LMS as a software system that combines a number of different tools that are used to systematically deliver content on-line and to facilitate the learning experience around that content.

Although Weller (2007) defines LMS in broad terms, LMS is a rather broad enveloping concept, which can mean different things to different people, depending on the application.

According to Ellis (2009), a simple definition will not suffice and a robust LMS should be able to do the following:

- centralize and automate administration,
- use self-service and self-guided services,
- assemble and deliver learning content rapidly,
- consolidate training initiatives on a scalable web-based platform,
- support portability and standards, and
- personalise content and enable knowledge reuse.

To complicate matters even more, the term Managed Learning Environment (MLE), has become popular. To generalise, MLE encompasses all the systems of an institution, for example a university, which includes the learning systems, as well as the administrative systems that contribute to learning and management of learning (Weller, 2007).

Weller (2007) argues that an LMS has three dimensions to its functionality:

- Institutional: One must be able to integrate an LMS into other university systems, for example, student records, library systems, content management and so forth. This will be one of the main tasks for the IT specialists responsible for the installation and maintenance.
- Academic: Although the end users of an LMS are the students, the academic staff will determine the success of an LMS. It is they who have to create the courses, set up the different tools and resources on the LMS and give support to the students.
- Learner or end-user: If they do not have a worthwhile experience, for example, have difficulty navigating the LMS, the feedback will be negative, which will inhibit its acceptance.

Weller (2007) further states that the system has to add value to the education of the students and if this is not the case, the students will refrain from using it.

To summarise, there is still some contention as to what the functions of the different e-learning software systems are and what it should be termed. Learning management system, with the acronym LMS, is the most widely used and accepted term for e-learning systems.

For the purposes of this study, an LMS is a software system that is used to systematically deliver content on-line and to facilitate the learning experience around that content.

3.5. MISCONCEPTIONS ABOUT E-LEARNING

Dublin (2003) and Garrison and Anderson (2003) argue that there are many misconceptions and unknowns about e-learning. This section will summarise some of these misconceptions, according to the abovementioned authors, in an effort to clear up some of these fallacies.

- **Everybody knows what you mean when you talk about e-learning**

Due to the fact that e-learning is still a new and emerging field and only became a popular term from the early part of the century, it still means different things to different people. It was originally called internet-based training and then web-based training which later made room for the buzzword e-learning. It seems if this coined phrase was a favourite term amongst those involved in the industry and came at a time when the “e” in front of certain words gave an allure to that specific word. Think of e-commerce, e-banking, e-letters, e-vouchers, etc. Various definitions were introduced, amended and discarded or accepted. In the end it all came down to the same concept. E-learning is learning that is facilitated by ICT, independent of the specific media used in learning. From this it is understandable why so many learners are confused regarding what constitutes e-learning and why so few managers or instructors seem to be able to correctly apply this form of learning.

- **E-learning is really no big deal**

Perhaps as result of the confusion surrounding the exact meaning of e-learning, some role-players may feel that e-learning is not the “next big thing”. However, even cursory research into the subject will reveal that this is not the case. Various organisational societies, structures and movements have been created to set and govern the standards of e-learning. These include the Sharable Content Object Reference Model (SCORM) which is produced by Advanced Distributed Learning (ADL), The International E-Learning Association (IELA), the eLearning Guild, Joint Information Systems Committee (JISC), Association for Learning Technology (ALT), to name but a few. E-learning is also practised and applied at a growing number of universities.

- **The “Hard-Stuff” aka the Technology” is what is really difficult**

There is a misconception that the growth of e-learning is being stunted by complex technologies. Dublin (2003) also hints at the fact that humans are a complicated species, who resist change and this factor, rather than the unemotional technologies involved, is responsible for the less than optimal growth of e-learning.
- **Technology is only a means of transmitting information**

Another misconception that exists about e-learning is that technology is only a means of transmitting information. The unique characteristics and capabilities of e-learning are redefining our approach to learning, which necessitates the need for a paradigm shift.
- **It is the learners who really count**

Learners are but one of the stakeholders in an organisation that is implementing an e-learning project or creating an e-learning environment. Yes, they do ultimately become the users of the system but all the stakeholders have an interest and should be as well managed as any other resource.
- **Learners know what to expect from e-learning**

It can be argued that learners typically do not know what to expect from e-learning and that one of the main reasons is the lack of one accepted definition of e-learning. Poor marketing of e-learning also plays a role.
- **Communication enables us to tell our stories**

Dublin (2003) quotes the American Heritage dictionary’s definition of communication as “the exchange of thoughts, messages, or information.” The operative word in this definition is *exchange*, which implies a two-way process. The idea is not to enforce a marketing communications plan with the purpose of telling a story, but rather to open up a communications channel so that an e-learning project can benefit from the input its stakeholders have to offer.
- **Success is getting it to work**

The mere installation of a working e-learning system is only the first step and also the least difficult. Where it gets more difficult is the implementation and integration. If the technology works, the installation stage can be seen as successful and if the learners use and benefit from the e-learning system then the implementation stage is going according to plan. The most difficult stage is the integration of the system where the e-learning becomes imperceptible and part of the regular business processes.

- **Once is enough**

As with most systems being developed, it is a continual process that must be learned from and improved on when repeated.

- **It is magic**

There is no model or method to follow that will assure success. It is also one of the goals of this study (refer to section 1.3) to look into this statement. Is there really no development method one can use to ensure the success of an e-learning system?

It is apparent that much more effort will be required to get the masses to embrace e-learning and with a certain degree of propagation, we can stimulate interest in this field and in turn eradicate the misconceptions and lack of knowledge that surrounds e-learning.

3.6. OPEN-SOURCE VS. PROPRIETARY LMS

There is a plethora of LMS software options available. Literally 100's of commercial learning management systems have been developed and the market seems to be increasing. In a recent study by Richard Nantel on the availability of commercial LMS software, it was found that there was a marked increase in the number of LMS products from 2008 to 2009 (Nantel, 2009).

An organisation will often be faced with a decision of whether to buy or to develop. Open-source projects, such as the Sakai project can also be considered, but a certain degree of in-house development or expertise is still necessary to deploy and maintain the system. When procuring an e-learning system one can divide the options into two main groups, namely: proprietary or open-source.

3.6.1. OPEN-SOURCE LMS

Open-source software is getting increasingly popular due to the economical and modular benefits it can offer.

According to Weller (2007) and the Open Source Initiative (2013), open source can be seen as the legal framework for the shared development and use of code. The contributors of an open-source project also share a belief about how the code should be developed. Under an open source framework software can be developed for any purpose.

There is a number of open-source LMS software available but the two that have the greatest market share, and will also subsequently be discussed, are Sakai and Moodle.

The Sakai Project

According to the Sakai Project's website, "Sakai is an Open Source Collaboration and Learning Environment (CLE) which is in Enterprise use at more than 300 Universities around the world." Millions of users use Sakai daily in their teaching and learning. Sakai was founded in 2004 by the University of Michigan and Indiana University, when both universities were independently developing their own CMS to replicate and enhance their current CMS. MIT and Stanford followed soon after and together with Open Knowledge Initiative (OKI) and the uPortal consortium they formed the Sakai Project.

Sakai provides an application framework and associated CMS tools and components that are designed to work together. These components are for course management, and, as an augmentation of the original CMS model, they also support research collaboration (Sakai Foundation, 2013).

The Sakai LMS is aimed mainly at universities, which also make up the largest portion of their partners.

Moodle

Moodle is perhaps the most popular open-source LMS software, and was originally an acronym for Modular Object-Oriented Dynamic Learning Environment. According to the Moodle website, Moodle is an Open Source Course Management System (CMS), also known as a Learning Management System or a Virtual Learning Environment. It has become very popular among educators around the world as a tool for creating on-line dynamic websites for their students and can essentially be seen as is a software package for producing Internet-based courses and websites. It is a global development project designed to support a social constructionist framework of education (Moodle Trust, 2013).

To give an idea of how popular e-learning is getting, one can use statistics from Moodle's website. As on 12 September 2013, Moodle had 87, 079 registered sites in 239 countries with a total of 73, 727, 178 users (Moodle Trust, 2013). E-learning is growing at an exponential rate.

Other open-source LMS's

Simpson (2009) advocates many alternatives to using Moodle, which include: Docebo, eFront, Dokeos, Claroline, ATutor, .LRN, etc.

3.6.2. PROPRIETARY LMS

In contrast to open-source LMS software, proprietary software is produced and owned by a software company or software producer. Users of such software pay licensing fees and do not have access to the source code. Almost all proprietary software is also commercial software, but some open-source software can have support on a commercial basis as well (Weller, 2007).

WebCT and Blackboard

WebCT or Web Course Tools was originally developed at the University of British Columbia in 1995 and can best be described as an on-line proprietary VLE or LMS. At its peak, WebCT was used by more than 10 million students in 80 countries. WebCT was acquired by one of its rivals, Blackboard, in 2006 (Blackboard Inc, 2013).

Blackboard is one of the main competitors in the proprietary LMS market.

SharePointLMS

SharePointLMS is another LMS worth mentioning and is based on the Microsoft Office SharePoint Server 2007/2010 platform. It was developed by a company called ELEARNINGFORCE in 2007 in Denmark and is becoming ever more popular, due to the minimal technical knowledge that deployment requires.

Saba

Saba is a leading provider of Learning Management, Talent Management, Performance Management, and Cloud Collaboration Software Solution (Saba Software Inc., 2013). Nowadays, Saba can be seen as the industry standard in proprietary LMS software and has over 31 million users. Their software is used to train the employees of some of the world's best-known companies, including the likes of Amazon, Toyota and KFC.

3.7. E-LEARNING OBJECTS AND STANDARDS

In this section some of the more important e-learning objects and standards, pertaining to this study, will be discussed.

Wagner (2002) delves into the significance of learning objects for creating learner-centred solutions and tools. Objects are stand-alone data elements that can hold content, learning

and knowledge. The use of objects has the potential for a personalised learning experience and reusability.

Wagner (2002) sums up the commercial success of e-learning, in terms of providing courseware for corporate training and how customers or content owners, want the assurance that they will be able to use their content on different platforms. The reusability of content and the ability to customise e-learning applications are some of the benefits of using learning objects.

Learning objects have evolved through many phases with ADL's SCORM having the greatest influence on e-learning.

3.7.1. SHARABLE CONTENT OBJECT REFERENCE MODEL (SCORM)

SCORM is a suite of technical standards developed by the Advanced Distributed Learning initiative to develop common specifications and standards for technology-based learning, deployed over the internet. These standards enable web-based learning and content management systems to find, import, share, reuse, and export learning content in a consistent manner. In addition, it allows user tracking and reports to be generated based on learning objectives. Essentially, SCORM standardised the method of communication between e-learning courses and SCORM-conformant learning and content management systems (Cybermedia, 2008).

3.7.2. REUSABLE LEARNING OBJECT (RLO)

Reusable learning object is the smallest building block used in any e-learning environment. The main value of using the learning object approach/philosophy in training projects, is the idea that learning objects (LOs) can stand independently of a framework such as an e-learning section/course/program and be reused in a totally different training setting (Cybermedia, 2008).

Wagner (2002) lists some of the benefits of learning objects as:

- Increased value of content,
- Improved content flexibility,
- Improved updating, searching and content management, and
- Content customisation.

3.7.3. XML

XML (eXtensible Markup Language) came in answer to the limitations of HTML. These limitations include: content reusability and content formatting. The rules for content formatting of HTML allow for only one specific visual layout. XML on the other hand does not describe what the content looks like but rather focuses on describing the content within the XML document. Thus, one can format XML documents in many ways and for many platforms, making the document reusable. The principle of reusability is ideal for e-learning environments (Learning Solutions Magazine, 2013).

3.7.4. LEARNING OBJECT METADATA (LOM)

The IEEE Learning Object Metadata (LOM) standard specifies the syntax and semantics of Learning Object Metadata, defined as the attributes required effectively describing a Learning Object. Learning objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology-supported learning. This is usually encoded in XML (EduTechWiki, 2013).

3.7.5. IMS GLOBAL LEARNING CONSORTIUM

The IMS (Instructional Management System) Global Learning Consortium is an international association of vendors, universities and implementers who strive to enable the growth and impact of learning technology in the education and corporate learning sectors worldwide. IMS has two fundamental goals, namely to: define specific guidelines which guarantee interoperability between applications and services in e-learning and to support guidelines applications in international products and services. IMS has approved and published over 20 standards that include a wide variety of technologies that support or enhance the learning experience, such as web-based course management systems, learning management systems, virtual learning environments, instructional management systems, student administrative systems, ePortfolios, assessment systems, adaptive tutoring systems, collaborative learning tools, web 2.0 social learning tools, learning object repositories, etc. (IMS Global, 2013; Bianco *et al.*, 2005).

This section only touched on some of the objects and standards governing the development of e-learning systems. The use of standards and objects is very beneficial in developing e-learning systems of quality, as uniformity and expandability will be assured.

3.8. THE BENEFITS AND DRAWBACKS OF E-LEARNING SYSTEMS

In this section the unique features of e-learning will be discussed in order to better understand the inherent advantages and disadvantages of e-learning.

E-learning has a unique set of features that are listed by the WorldWideLearn (2013) website as:

- Learning is self-paced and gives students a chance to speed up or slow down as necessary
- Learning is self-directed, allowing students to choose content and tools appropriate to their differing interests, needs, and skill levels
- Accommodates multiple learning styles using a variety of delivery methods geared to different learners; more effective for certain learners
- Designed around the learner
- Geographical barriers are eliminated, opening up broader education options
- 24/7 accessibility makes scheduling easy and allows a greater number of people to attend classes
- On-demand access means learning can happen precisely when needed
- Travel time and associated costs (parking, fuel, vehicle maintenance) are reduced or eliminated
- Overall student costs are frequently less (tuition, residence, food, child care)
- Potentially lower costs for companies needing training, and for the providers
- Fosters greater student interaction and collaboration
- Enhances computer and Internet skills
- Draws upon hundreds of years of established pedagogical principles
- Has the attention of every major university in the world, most with their own on-line degrees, certificates, and individual courses.

Clark and Mayer (2003) state there are also three valuable instruction methods that are unique to e-learning: practice with feedback, collaboration in self-study and the use of simulation to accelerate expertise.

With the unique nature of e-learning comes a unique set of benefits and drawbacks, which brings opportunities to utilise, but also, many challenges to overcome.

It is important to understand that e-learning has different benefits and drawbacks for the different stakeholders⁴ of the system. The owners or organisations, which implement the e-

⁴ Stakeholders are the people involved in or affected by project activities (Schwalbe, 2010).

learning system, may see the advantages of this type of learning in another context as will the end-users, or learners, of the system.

Table 3.2 was derived from Kruse (2004) and Welsh *et al.* (2003) and lists the benefits and drawbacks of e-learning from the viewpoint of an organisation in the process of implementing e-learning.

Benefits	Drawbacks
<p>A Reduction in the cost of training This could be the single most important advantage of e-learning, according to an organisation. The cost reduction can be contributed to the elimination of costs regarding the meeting room rental, salaries of the instructor's, travel cost, etc.</p>	<p>Large initial investment to develop or acquire an e-learning solution. Costs include to design and build the actual courses.</p>
<p>Learning times are reduced by as much as 60 per cent.</p>	<p>Cultural acceptance can play a huge roll, where certain learners are predisposed to using computers.</p>
<p>Consistent delivery of content, made possible by asynchronous and self-paced learning.</p>	<p>Effective e-learning requires significant effort and planning.</p>
<p>Increased retention a feature of e-learning that can be used to ensure that trainees stay engaged in training. This is because part of the training/learning is conducted asynchronously, part synchronously and merely the most interactive part in the classroom.</p>	<p>Some organisations are concerned that only "pushing" digital information does not result in training.</p>
<p>Increased learner convenience, provided that the right technology is acquired.</p>	<p>Lack of interaction for trainees of on-line courses. A concern that is expressed by many organisations.</p>
<p>Manageable growth of information that employees/trainees/students need to learn.</p>	<p>Technology issues are also a factor in the sense that the current infrastructure could need an upgrade.</p>

Table 3.2: Benefits and drawbacks of e-learning for an organisation

Table 3.3 was surmised from Kruse (2004) and Welsh *et al.* (2003) and lists the benefits and drawbacks of e-learning from the viewpoint of a student, learner or trainee.

Benefits	Drawbacks
On-demand availability enables students to complete training conveniently at off-hours or from home	Reduced social and cultural interaction.
Self-pacing for slow or quick learners reduces stress and increases satisfaction.	Certain technologies required for e-learning may not be available everywhere.
Interactivity engages users, pushing them rather than pulling them through training.	Digital study guides and course material cannot rival printed media and reference material.
Confidence that refresher or quick reference materials are available reduces burden of responsibility of mastery.	

Table 3.3: Benefits and drawbacks of e-learning for a student, learner or trainee

Holmes and Gardner (2006) discuss the benefits of e-learning by asking four questions:

- *Who is given the opportunity to be an e-learner?* There are various people in all walks of life that are using e-learning and with the inherent properties of e-learning no one is excluded from education by socio-economic, geographical or physical limitations.
- *What is to be e-learned?* E-learning can accommodate any type of learning.
- *How will learners engage with e-learning?* E-learning models that focus on collaboratively sharing information and transforming it into knowledge instead of traditional methods that focuses on teaching a set of standards. If appropriately applied the learner-centred approach to learning will help learners manage rapid changes in personal and workforce environments.
- *Where and when will learners engage with e-learning?* One of the greatest benefits of e-learning is the non-issue of physical limitations. People can learn from anywhere and anytime.

To summarise, e-learning means different things to different people (refer to section 3.5) and as such has different benefits and different drawbacks for the various role players. One of the biggest benefits is the vast number of students e-learning can target at any given time and that students have the added convenience that they can learn almost anywhere in the world and at any time of the day. Benefits such as these have to be weighed against drawbacks such as the high initial cost it takes to establish an LMS environment and the technology issues to overcome.

3.9. CHALLENGES AND OPPORTUNITIES

With most new technologies there is a certain initial reluctance towards adopting a specific technology. This is no different for e-learning. Actually one can speculate that it is even more difficult for people to change their manner of learning as opposed to adopting other technologies.

Ali and Magalhaes (2008) report an internal resistance from learners to using technology, as one of the most notable obstacles when trying to implement e-learning. Even the best on-line course will fail if you are unable to convince learners to partake in the course.

Clark and Mayer (2003) identify e-learning attrition or dropout as the greatest challenge inherent to e-learning. The term attrition means the decrease in the number of students involved in a certain course of study, for whatever reason.

Table 3.4 will summarise some of the literature that was reviewed on the reasons for attrition or the dropout of learners from e-learning courses.

Martinez (2003) reckons it is more challenging to keep on-line learners engaged and enrolled in courses and that it takes special skill and management strategies to deal with retention issues.
Frankola (2001) and Moshinskie (2001) reported completion rate as potentially problematic with instruction that is technology-delivered.
Welsh <i>et al.</i> (2003) suggested that that the attrition rate for technology-delivered teaching was higher, in cases where there was no real motivation for completing a course, than that of instructor-led courses.
Garrison (2011) believes that higher education requires new ideas and approaches to keep learners engaged, which could be challenging.
E-learning has to overcome the lack of face-to-face contact (Holmes & Gardner, 2006).
The e-learning context makes the important teaching role, of integrating the various elements of the educational experience, even more challenging than normal teaching methods (Garrison, 2011).
Garrison (2011) states that the increasing importance of technology in e-learning represents constraints for interaction, which can have a significant impact on the educational process.

Table 3.4: Challenges e-learning faces due to attrition

According to the literature, there are many barriers when it comes to adopting e-learning. Attrition rates are high and one of the biggest challenges is the lack of face-to-face contact with students. This could be overcome by blended learning methods (Holmes and Gardner, 2006). One has to be aware of these challenges that e-learning faces, in order to best ascertain how to make use of the opportunities available.

E-learning also provides many opportunities; to name but one, the vast number of people you can reach with e-learning's delivering methods. E-learning lends itself to the use of multimedia instruction technologies that enhances the learning experience (Mayer, 2011). Mayer argues that people can learn better from multimedia instruction than from words alone, and describes this with the term *the multimedia principle*⁵.

⁵ A term coined by Mayer (2009).

One of the most significant opportunities provided by appropriately designed e-learning systems is that the learners can create and acquire knowledge for themselves. Many opportunities are offered by e-learning for educators and learners alike. LMSs support not only the delivery but also the exploration and application of knowledge (Holmes & Gardner, 2006).

Garrison (2011) believes that e-learning provides the following opportunities:

- expands educational capabilities, opportunities and choices;
- can extend interaction;
- have a positive transformation on approaches to teaching;
- provide opportunities for connection and reflection; and
- medium supports sustained and reflective dialogue.

To develop e-learning systems of a high standard, one can perhaps utilise the potential benefits to the various parties involved, as well as addressing some of the opportunities that the e-learning paradigm provides.

3.10. CRITICAL SUCCESS FACTORS OF E-LEARNING

The concept of classifying factors, that can be applied to business problems, to promote their chances of success is definitely not a new one and dates back to the 1960s when D. Ronald Daniel defined the original concept of *success factors* (Daniel, 1961).

The term critical success factors (CSF) first appeared in research literature in the 1980s, when the components that made some organisations more successful than others, were examined (Ingram *et al.*, 2000). The actual CSF approach was developed by John F. Rockhart of MIT's Sloan School of Management as an answer to the challenges that top management faced, as result of information overload. Rockhart's team focussed on the connection between CSFs and information systems and technology. Rockhart expanded on the work done by Daniel in the 1960s (Rockhart, 1979).

Both concepts have the underlying objective of managing organisations more effectively, which ultimately depends on high-quality information and the accessibility of technology. From there, the connection between CSFs and information systems were created (Caralli, 2004).

Selim (2007) stated that CSFs should be few in number, measurable and controllable.

One can thus deduce that to be able to improve on e-learning systems, one has to define the critical success factors of e-learning. There is little research available on what exactly the CSFs of e-learning are supposed to be.

Papp (2000) researched distance learning from a macro-perspective and recommended some CSFs that could assist universities in the development of e-learning environments. This included intellectual property, suitability of the course for the e-learning environment, building the e-learning course, e-learning course content, e-learning course maintenance, e-learning platform, and measuring the success of an e-learning course. Papp (2000) also suggested that these factors should be considered separately and in combination, to determine which factors have the most influence.

Benigno and Trentin (2000) proposed a framework for the evaluation of e-learning courses: they considered factors, such as student characteristics, student–student interaction, effective support, learning materials, learning environment, and information technology.

Based on all the above findings, Selim (2007) argued that e-Learning CSFs within a university environment can be clustered in the following categories: information technology; instructor; student; and university support. Selim (2007) went on to test his argument by developing various indicators for the different CSF groups. Selim (2007) tested them, using a population of 538 students at the United Arab Emirates University for various on-line courses.

Selim (2007) used a Confirmatory Factor Model (CFM) approach to validate the underlying critical indicators in each of the CSF categories. The result of his study established that the CSFs of e-learning should be expanded to the seven categories which will be described in Table 3.5.

Factor	Description
Instructor Involvement	Characteristics, attitude towards learners, e-skills literacy, ability to encourage learners to participate
Student Computer Competency	Ability to use and promote computing technology as it is applied to learning
Student Collaboration	Collaboration between Student and Student and Student and Instructor
E-learning Course Content and Design	Student's perception about interactivity, efficiency and effectiveness of e-learning system
Technology	Ease of access and navigation, visual technology interface and IT infrastructure reliability and effectiveness
University/Company support to e-learning initiatives	Library services, help desk, computer labs and facilities
E-Learning Usage Factor	Intention of registering in future e-based courses, student's perception about e-learning in general

Table 3.5: Critical success factors of e-learning (Selim, 2007)

The critical success factors, suggested by Selim (2007), will be used in this study to determine which factors are more important towards the success of e-learning systems.

3.11. CONCLUSION

Although a solid foundation has been laid in the field of e-learning, one can clearly see that there is still much more research to be done. For example, there is still contention as to the exact definition of e-learning itself, as well as the naming conventions of the various learning management systems. The various definitions were discussed and definitions and terms pertaining to this study (sections 3.2, 3.3 and 3.4) were decided upon.

The misconceptions surrounding e-learning were discussed (section 3.5). The distinction between proprietary and open-source LMS markets was drawn, together with a mention of

the most prolific role-players in each (section 3.6). Great strides have been made in the way e-learning development is being standardised and regulated (section 3.7).

It is apparent that the e-learning paradigm has a great many benefits on offer, if one stays clear of the pitfalls inherent to e-learning (sections 3.8 and 3.9).

Seven critical success factors of e-learning were identified. This gives a basis to measure the success and quality of an e-learning system against the critical CSFs (section 3.10).

The main focus of this study is to determine if, and what methodologies can be used, to increase the chances for developing successful e-learning systems that will be beneficial to the learners, teachers and the organisations, alike.

In the next chapter, the literature review on systems development methodologies will be discussed.

CHAPTER 4

SYSTEMS DEVELOPMENT METHODOLOGIES

4.1. INTRODUCTION

The aim of this chapter is to give a review of systems development methodologies, as it is an integral element of this study. This chapter will highlight those elements of SDMs that are relevant to this study. Firstly, a brief overview on the background of SDMs will be given (section 4.2), then a clarification of the definition of SDMs will be made (section 4.3), the use (section 4.4) and effectiveness (section 4.5) of SDMs will be discussed and certain SDMs, used specifically for web-based systems, will be mentioned (section 4.6). The concept of methodologies used, specifically for Instructional Systems Design, will also be introduced, as well as SDMs for e-learning systems (section 4.7).

4.2. BACKGROUND

Prior to the 1970's computer applications were implemented without the use of any formal systems development methodologies. The success or failure of such systems depended largely on the skill and experience of individual programmers. History shows us that systems development methodologies came into existence to address the shortcomings in existing techniques and to improve on the productivity and quality of software (Avison & Fitzgerald, 2002; livari *et al.*, 2000).

Huisman and livari (2006) argued that using a systems development methodology is more effective than not using one. SDMs introduce a certain structure to the development process, which in turn improves the effectiveness of the design process and facilitates more consistent outcomes.

In the 1970's the main goal of systems development methodologies was to deliver information systems that were timely, within budget and satisfied the user requirements (Walters *et al.*, 1994). Literally hundreds of SDMs exist, although many have fallen into disuse (Jayaratna, 1994). Some of the better-known SDMs include Structured Systems Analysis and Design methodology (SSADM), Coad-Yourdon's Object-Oriented Analysis Design methodology (OOADM), Information Engineering (IE) and later on, Agile methodologies. We will return to agile methodologies in section 4.6.2.

Avison and Fitzgerald (2003) devised four distinct categories that describe this evolution of SDMs through the years, namely pre-methodology era, early methodology era, methodology era, and post-methodology era. A short description of these eras will follow:

- **Pre-methodology era:** Computer applications were developed on an ad-hoc basis and developers had little or no understanding of the business where the software systems were to be implemented. Software developers worked alone in their areas of expertise with little regard for business requirements (Boehm, 1988).
- **Early methodology era:** The introduction of the Systems Development Life Cycle (SDLC) in the late 1960's, which became the de facto systems development methodology of the 1970's (Lee, 1987).
- **Methodology era:** Due to the failings of the SDLC, a number of newer methodologies emerged in the methodology era, with the purpose of producing better end products, improving the development process and creating a standardised process for software development within an organisation. These methodologies can be categorised in various approaches: structured, data-driven, object-oriented and prototyping (Walters *et al.*, 1994; Avison & Fitzgerald, 2003).
- **The post-methodology era** has seen many companies overwhelmed by the multitude of SDMs that they can choose from, and often they are unsure of whether they need to use a methodology (Avison & Fitzgerald, 2003). There seems to be a movement away from the use of methodologies and many organisations elect to modify existing methodologies in order to suit their needs, as opposed to using the SDMs as is (Beynon-Davies & Williams, 2003). Truex *et al.* (2000) also believe that SDMs are being adapted to suit each unique development situation. The term *contingent⁶ use of systems development methodologies* is also associated with the post-methodology era where organisations are choosing a "best fit" SDM to suit the needs of their current and future development projects (Ketunnen & Laanti, 2005). Refer to section 6.2.3 where the findings of the measurement element on SDMs will be discussed.

⁶ Contingent use of systems methodologies can be seen as the use of systems development methodologies in such a manner that provision is made for future systems development projects that are of the same nature. Contingency also applies to the tailoring of existing systems development methodologies (Ketunnen & Laanti, 2005).

Seven broad approaches to methodologies emerged during the methodology era (Avison & Fitzgerald, 2003) and these will subsequently be listed in Table 4.1.

Approach	Description
Structured	Concepts of structured programming were used and techniques, such as data flow diagramming enabled the top down analysis and representation of complex processes.
Data Oriented	Emphasis was placed on the understanding of data as the key element and the most prominent technique used was entity relationship modelling.
Prototyping	An approximation of the system was first built so that users could visualise and respond to it prior to its physical implementation.
Object Orientated	The identification of objects, attributes and classes helped provide the theoretical benefits of inheritance and reuse.
Participative	The crucial feature was involvement of users and stakeholders.
Strategic	The emphasis was on the planning of information systems and the development of an information systems strategy to support and enable the overall objectives of the business.
Systems	The complexities of human activity systems were addressed by adopting a holistic view far beyond a system's single application boundaries.

Table 4.1: Seven approaches to methodologies (Avison & Fitzgerald, 2003)

4.3. DEFINITION

There has been much contention over the precise definition of the term, Systems Development Methodology. Wynekoop and Russo (1997) and Avison and Fitzgerald (2006) argue that there is no universally accepted and exact definition of what is implied by SDMs. This makes defining SDMs challenging.

Some examples of the disparate definitions include:

- A systems development methodology is a systematic procedure for completing either a system or one of several stages of the systems development life cycle. It consists

of goals, principles and specific methods and tools, which are selected on the basis of an underlying rationale or system development philosophy (Iivari *et al.*, 1999).

- A systems development methodology is a collection of procedures, techniques, tools and documentation aids that will help systems developers in their efforts to implement a new information system. A methodology will consist of phases, themselves consisting of subphases, which will guide the systems developers in their choice of the techniques that might be appropriate at each stage of the project. It also helps them plan, manage, control and evaluate information systems projects. The methodology must also be based on some philosophical view (Avison & Fitzgerald, 1995).
- Wynekoop and Russo (1995) defined a methodology as an orderly approach to carry out at least one stage of the systems development life-cycle, by using relevant tools, techniques, or guidelines, based on an underlying philosophy.
- Avison and Fitzgerald (2006) defined an SDM as a way to accomplish the development (or part of the development) of software, established on a set of rationales and an underlying philosophy. This includes a definition of phases, tasks, tools, guidelines and documentation.

A contributing factor to the ambiguity surrounding the various definitions of SDMs, could be that the distinction between what is implied by a method and what is implied by a methodology, is unclear. Some researchers argue that the term methodology is unsuitable since it literally means a "science of methods" and thus does not make any sense in the field of information systems (Baskerville *et al.*, 1992; Schach, 1997). Others reason that the terms can be applied interchangeably, as they basically establish the same underlying development principles (Connors, 1992; Saeki, 1998). Hirschheim *et al.* (1996) see methods as a part of methodologies. This view will also be used for this study.

Huisman (1999) identified four key elements from several of the more significant definitions in the literature:

- The systems development methodology itself.
- A systems development methodology is based on some philosophical view or approach.
- A systems development methodology includes a set of techniques.
- A systems development methodology follows a process model.

When one takes into account the four elements identified above, the following definition of a systems development methodology was developed (Huisman, 1999):

- **Systems development approach**

This can be defined as the philosophical view on which the methodology is built. Thus, the set of goals, guiding principles and beliefs, basic concepts and principles of the systems development process that drive interpretations and actions in systems development (livari *et al.*, 1998; livari *et al.*, 1999). Examples of systems development approaches are the structured approach, object-oriented approach, information modelling, etc.

- **Systems development process model**

Wynekoop and Russo (1993) define a process model as a representation of the sequences of stages through which a system evolves. Some examples of process models are the linear life-cycle model, the spiral model and incremental model.

- **Systems development method**

A method is a systematic approach to conducting at least one complete phase of systems development, consisting of a set of guidelines, activities, techniques and tools, based on a particular philosophy of systems development and the target system (Wynekoop & Russo, 1993). Examples include IE, SSADM, etc.

- **Systems development technique**

A systems development technique consists of a well-defined sequence of actions, ensuring successful results if used correctly (livari *et al.*, 2000; Brinkkemper, 1996), for example entity relationship diagrams and data flow diagrams.

This definition of SDMs implies that there is a development approach that guides the development. All the facets that need to be included in the development are underpinned in this approach. The process model, in turn, defines the order in which the development steps are carried out and is dependent on the development approach. The development method is what has to be done in order to develop the system, given the approach. The techniques are instruments used in accomplishing the steps of the development. All this adds up to what is called a systems development methodology. *This encompassing definition will also be used for this study.*

4.4. THE USE OF SYSTEMS DEVELOPMENT METHODOLOGIES

Whether systems development methodologies are being used in practice has been a point of interest for academics for an extended period of time. It is argued that the use of SDMs will

aid in the development process by making it more effective, secure, predictable and easier to control, whilst improving productivity and quality (Fitzgerald *et al.*, 2002).

There is not much empirical research that supports the use of SDMs. Some of the empirical research that could be found will subsequently be listed:

- Russo *et al.* (1995) found that only 6% of developers followed an SDM rigorously.
- Chatzoglou and Macaully (1996) found that 47% of their population had never used a methodology.
- Avison and Fitzgerald (2003) also found this number to be low.
- Less than 50% of organisations follow SDMs strictly (Glass, 1999).
- Huisman and Iivari (2006) determined that when SDMs are being used in practice, it is not to the full extent.
- Fitzgerald *et al.* (2002) show that the use of formalised SDMs was significantly higher in larger organisations (more than 1 000 employees) and larger IS departments (more than 20 personnel).
- In recent studies conducted by Brits (2011) and Janse van Rensburg (2012) it was found that 74% of organisations in South Africa make use of SDMs.
- Conradie (2010) and Wagener (2012) also found this number to be above 75%.

Other research shows that systems development methodologies are used, but not exactly as intended and these SDMs are adapted to suit the requirements of a specific development project (Fitzgerald *et al.*, 2002; Dietrich *et al.*, 1997; Hughes, 1998).

The use of SDMs is encouraged and recommended for various reasons (Fitzgerald, 1996; Humphrey, 1989; Fitzgerald *et al.*, 2002):

- Firstly, organisations are under pressure to maintain their competitiveness by adhering to international standards as set by the International Standards Organisation (ISO).
- Secondly, the Software Capability Evaluation Program of the Software Engineering Institute assesses the capability of organisations to produce high-quality software on time. This program emphasises adherence to formalised development procedures.
- Thirdly, some governments are enforcing systems development standards. By doing so, they force organisations that deliver software to them, to use the appropriate systems development methodology.

At this stage it is worth mentioning some of the reasons why SDMs may not be used rigorously, or used at all:

- Pfleeger (1999) and Fitzgerald *et al.* (2003) argue that SDMs may be too rigid, not adaptable and that the techniques described by the SDM may be unsuitable.
- The movement towards agile methods, which are supposed to address abovementioned concerns, are not happening as promptly as initially thought. Organisations are slow to adopt agile SDMs and it could be because such a move would imply a change in management style, adjustments to new systems development processes and the need for better compatibility of technologies (Ambler, 2008; Nerur *et al.*, 2005).
- SDMs may possibly not suit the social characteristics of the development team or organisation (Gallivan, 2003).

There is not all that much empirical research available on the actual use of SDMs. Huisman and livari (2003) stated as much. As we are currently in the post-methodology era, the nature of the use of SDMs is changing and software development companies seem to adapt SDMs as needed for a specific project. There is even less research being done on the use of SDMs in developing e-learning systems and none of the research has any empirical evidence. This study (refer to section 1.3) will aim to provide some empirical results on the use of SDMs in developing e-learning systems (LMSs).

4.5. THE EFFECTIVENESS OF SYSTEMS DEVELOPMENT METHODOLOGIES

Empirical research on the effectiveness of SDMs is very limited, which seems to be due to the lack of standard criteria that measures SDM effectiveness (Conradie 2010). This section will confer the results on the effectiveness of SDMs that were found in the literature.

Although many SDMs have been successfully utilised over the years, there have been many software failures, which has questioned the relevance of SDMs. Even with the use of SDMs, projects are still being abandoned halfway, still overshooting the budget, and still not being delivered within an appropriate time frame (Truex *et al.*, 2000; Gruner *et al.*, 2007). However, great strides have been made in the last four decades; yet there is still much to be learned from studies into the effectiveness of SDMs.

Due to the lack of standard measurements to ascertain SDM effectiveness, Vavpotic and Bajec (2009) presented a model for evaluating SDMs. They used a two-dimensional

approach considering social and technical factors. In the social dimension the focus was on the appropriateness of an SDM concerning the social and cultural qualities of a development team. In respect of the technical dimension, the appropriateness of an SDM with regard to the technical qualities of a project or organisation was considered.

The following list indicates the five factors Vavpotic and Bajec (2009) considered in their effectiveness measurement and the variables it was measured against.

- Implication of SDM use on software product: quality, usability, reliability, maintainability and efficiency of the new system.
- Implication of SDM use on software project or process: time consumption, project costs, project control and estimation of project risks.
- Implication of SDM use on the SDM users: facilitation of collaboration, understanding of responsibilities and duties.
- Implication of SDM use on the organisation: facilitation of standardisation, improvement of an organisation's reputation.
- Implication of SDM use on customers: increase in customers' trust in the organisation, increase in satisfaction with the organisation.

Vavpotic and Bajec (2009) tested their SDM evaluation model in four different case studies and in all the cases the same pattern emerged, which confirmed their evaluation model as a valuable method for testing and explaining the effectiveness of SDMs.

There are several compelling reasons for using SDMs. Some of these endorsements for the effectiveness of SDMs that were found in the literature will be listed in Table 4.2.

Fitzgerald <i>et al.</i> (2002) state that systems development methodologies have been endorsed by the literature, as being capable of ensuring that the development process is more effective, secure, predictable and easier to control.
Gruner <i>et al.</i> (2007) argue that it is challenging and precarious to develop software without the guidance or structured process that an SDM can provide.
Huisman and Iivari (2006) reasoned that SDMs introduce structure to the design process, thereby improving the effectiveness of software development and thus ensuring more consistent outcomes.
The use of software methodologies is said to decrease the risk of failure of an information system (IS) project (Hull <i>et al.</i> , 2002; Avison & Fitzgerald, 2003).

Table 4.2: Motivating reasons for using SDMs

There are also several other potential benefits to using methodologies (Avison & Fitzgerald, 2003; Ambler, 2001).

- Methodologies assist in accurately specifying the requirements for an information system.
- Development follows a systematic approach, which means that progress can be monitored effectively.
- Methodologies ensure that an information system is completed within an appropriate time frame and at a cost within the project's budget.
- With SDMs, if used correctly, sufficient documentation will be produced and this will make for easier maintainability in the future.
- Methodologies assist in giving an early indication of the changes that need to be done during the development process.
- Methodologies provide a managed approach to the development of information systems by following a standardised process, which promotes reuse and consistency. In the end a better quality product is created.
- A methodology improves the organisation's operations and support efforts by managing change and facilitating the smooth transition of software into operations and support.

As mentioned earlier in this section, there is a lack of empirical evidence supporting the claim to effectiveness that SDMs have. Nonetheless, there is evidence of such and some of the empirical research, which could be found in the literature, will subsequently be summarised:

- i. Fitzgerald *et al.* (2002) conducted empirical research that confirms that formal SDM use was substantially higher in organisations with more than a 1000 employees.
- ii. An empirical study by Reifer (2002) reflects the advantages that organisations experienced from using agile methodologies:
 - An increase in productivity of 15% to 23% was reported by the organisations that participated in the survey.
 - A cost reduction of between 5% and 7% was reported.
 - The time-to-market was reduced by up to 50% compared to previous projects.
 - 16% of the organisations experienced a definite improvement in quality due to the utilisation of SDMs.
- iii. A study on agile methodologies, conducted by Shine Technologies (2003) yielded the following results:
 - 88% of organisations cited an improvement in productivity.

- 84% of the organisations indicated an improvement in the quality of software production.
 - 49% of the organisations in the study stated that they experienced a significant reduction in costs when using agile methodologies.
 - 83% also stated that business satisfaction with the software, and the process followed to develop it, was significantly higher.
- iv. Brits (2011) reported a very strong relationship ($p < 0.001$)⁷ between the use of SDMs and ultimately the success of the information system projects.

There is generally a lack of empirical studies done on the effectiveness of SDMs in developing software. Many of the studies were conducted on agile methodologies. The reason for this could be that the popularity of agile methodologies is steadily increasing since their introduction in the 1990's (Good, 2003). The studies that could actually be found indicated that there is merit in the statement that SDMs can be used to promote the chances of effectiveness in software systems. However, a standard accepted measurement model has to be developed and tested. Wynekoop and Russo (1997) suggested that the following variables need to be utilised in efforts to develop a measurement to determine SDM effectiveness: user satisfaction with the product, developer satisfaction with the process, design complexity, system maintainability quality and developer productivity. The measurement element used in this study will adhere to these recommendations.

4.6. SYSTEMS DEVELOPMENT METHODOLOGIES FOR WEB-BASED SYSTEMS

This section will touch on some of the SDMs designed specifically for web-based systems. Due to the reusable and object-oriented nature of e-learning one has to consider SDMs that can develop software in the same manner. LMSs are also almost exclusively web-related. It is therefore worthwhile to review SDMs that are being utilised for web-based information systems.

After the post-methodology era a number of new methodologies have seen the light, such as component-based development, extreme programming and web-related software development methodologies. This section will discuss these.

⁷ See section 2.6 to see a clarification on this value.

4.6.1. COMPONENT-BASED SOFTWARE DEVELOPMENT

As time and resource constraints have become more unyielding in the post-methodology era, component-based development is being regarded as an important addition to existing SDMs. It is capable of meeting rigid constraints in an effective manner (Vitharana *et al*, 2003).

Component-based software development (CBSD) can support the software industry to promote quality and productivity improvements, similar to those achieved in the hardware and manufacturing industries. This is due to the fact that CBSD can trace its roots back to the concept of component fabrication and assembly (Brown, 2000; Szyperski, 1998).

A component can be defined as a piece of executable software that offers a set of related services through a published interface (Hopkins, 2000; Vitharana *et al*, 2003). One can read this section together with section 3.7, where the concept of learning objects was introduced. The CBSD methodology pursues the development of components required to support various functions and processes for a particular domain or area (Vitharana *et al*, 2003).

There are various domains that can benefit from components or component-based software. Once the components for a particular application or purpose are designed and developed, various systems are constructed by first selecting and then assembling the chosen components. It seems to address some of the issues that are present in the post-methodology era by reducing costs, development time and improving the quality of systems (Vitharana, 2003).

4.6.2. WEB APPLICATION DEVELOPMENT

The post-methodology era has been characterised by a need for rapid application development due to the competitive nature of software development. The evolution and growth of the Internet (refer to section 1.1) has changed software development's priority from what-to-deliver to when-to-deliver. Reduced development times are one of software engineering's most important missions (Aoyama, 1998).

In 2012 the E-commerce market reached one trillion dollars for the first time in history (eMarketer, 2013). Murugesan (1999) considers that this can be indicative of the number of web-based applications that have been developed recently. Although these applications are being deployed in large numbers, they are being developed in an arbitrary, anarchic and ad-hoc manner. Effective ways and techniques for ensuring the integrity and maintainability of

web applications are thus lacking. Although there are a few web development methodologies they are not used adequately enough.

A component-based development methodology that could be the answer to the development of web applications has been suggested by Lee and Shirani (2004). A component, in the context of web-based applications, is a system or a software program that has been pre-compiled to provide certain functionality. To facilitate the use of a component-based methodology, a web application can be considered as an assembly of collections with each collection consisting of one or more pages.

Martin Bauer, a development manager of web-based software, argues that agile methods are also very popular for web-based development (Bauer, 2005).

Agile software development is actually a group of SDMs based on iterative and incremental development and it encourages rapid and flexible response to change. This is ideal for ever-changing environments, such as web-based systems. Some of the agile methods include Extreme Programming (XP), SCRUM, Crystal Clear, Dynamic Systems Development Method (DSDM) and Feature Driven Development (FDD). They are collectively referred to as agile methodologies after the Agile Manifesto was published in 2001 (Larman, 2004).

Bauer (2005) evaluated many of the abovementioned SDMs and is of the opinion that FDD is the best suited for web-based applications (Bauer, 2005).

FDD was initially devised by Jeff de Luca in 1997 to meet the requirements of a large software development project done for a Singapore bank. The steps in FDD as outlined on Nebulon's website (Nebulon, 2013a; Nebulon, 2013b) are as follows:

- **Process 1: Develop an overall Model**
This is an initial project-wide activity with domain and development members under the guidance of an experienced object modeller in the role of Chief Architect.
- **Process 2: Build a features list**
This is an initial project-wide activity to identify all the features required to support the project requirements.
- **Process 3: Planning**
This is an initial project-wide activity to produce the development plan.
- **Process 4: Design by feature**
This process involves a per-feature activity to produce the feature design package. This process is broken down into three steps: walkthrough, design and inspection.

- **Process 5: Build by feature**

This process involves a per-feature activity to produce a completed client-valued function (feature).

This process is also broken down into three steps: code, code inspection, and promote to build. As with process 4, the idea of collaboration and benefits inspections is enforced. What makes this process unique is the final step, namely “promote to build”.

One can ascertain that due to the tremendous growth of the Internet, and especially the e-commerce market, there exists a need for web-based systems development methodologies that can cope with the fast pace at which web applications have to be developed.

Component-based and agile systems development methodologies have been suggested as an answer to the ever-changing environment of web-based systems. These methodologies are favourable to bring about prompt and flexible response to change, which is needed by these types of applications. It can be argued that a great many of the LMSs being used today are web-based⁸ and can thus be seen as a sub-set of web-based systems. In the next section SDMs for e-learning systems will be discussed.

4.7. SYSTEMS DEVELOPMENT METHODOLOGIES FOR E-LEARNING SYSTEMS

This section will survey the literature on what SDMs are available, specifically for LMSs and will give an overview of such SDMs.

It is worth noting that many of the methodologies are actually instructional design models rather than actual software development methodologies. This issue will be clarified within the following sub-sections by discussing the ADDIE model in section 4.7.1, eLearnXML methodology in section 4.7.2 and an e-learning systems engineering methodology in section 4.7.3.

4.7.1. ADDIE MODEL

The ADDIE model is an approach used by instructional designers and content developers to create instructional course materials. It can be seen as an iterative⁹ process of educational

⁸ A cursory evaluation into the statement that LMSs are a subset of web-based systems, confirmed this (Blackboard Inc, 2013; Saba Software Inc, 2013; Sakai Foundation, 2013; Moodle Trust, 2013).

⁹ The iterative nature of the ADDIE model is common to that of the agile methodologies (refer section 4.6.2).

design that instructional designers use to develop educational material. This model has been adopted and used by many instructional designers for its flexibility and support of rapid prototyping techniques (Morrison *et al*, 2010; Training Industry, 2013).

Although this model is described in the literature as an e-learning system development methodology, it is worth noting that it is actually an Instructional Systems Design¹⁰ (ISD) model. Piskurich (2006) argues that most current ISD models are variations of the ADDIE process. Thus, this study will only focus on the ADDIE model.

The five phases of the ADDIE model are subsequently listed and can be seen in Figure 4.1. It is important to note that each phase in the ADDIE model includes a feedback and quality control loop (Training Industry, 2013):

- **Analysis.** In the first phase, the instructional challenge of the course is detailed, objectives are established and issues, such as learner skill level are identified.
- **Design.** A variety of concerns are addressed in this phase to achieve optimal courseware design and systematic development of the training program. They include learning objectives, content, assessment instruments, exercises, subject matter analysis, lesson planning and media selection. Each is pursued under a logical and orderly method of identifying, developing and evaluating plans for meeting instructional goals.
- **Development.** Courseware designers and developers create the content following the design phase's blueprint. That includes design of storyboards and graphics, as well as integration of any e-learning technologies.
- **Implementation.** This phase focuses on developing procedures for training both facilitators and learners. Facilitators training should explain the curriculum, learning outcomes, method of delivery and testing procedures. Student preparation includes training the use of new software and hardware, and registration. Preparation of learning materials including books, tools, CD-ROMs and software is conducted, and the website tested.
- **Evaluation.** The evaluation phase is on-going throughout the design process. Its purpose is to ensure that all stated goals of the learning process will meet the specified needs. Another objective of this phase is to identify on-the-job performance following completion of the course, and to ensure that business needs are met.

¹⁰ Instructional Systems Design is the practice of creating instructional experiences which make the acquisition of knowledge and skill more efficient and attractive. This is done by determining the current state and needs of the learner, defining the end goal of instruction, and creating some "intervention" to assist in the transition (Merrill *et al.*, 1996).

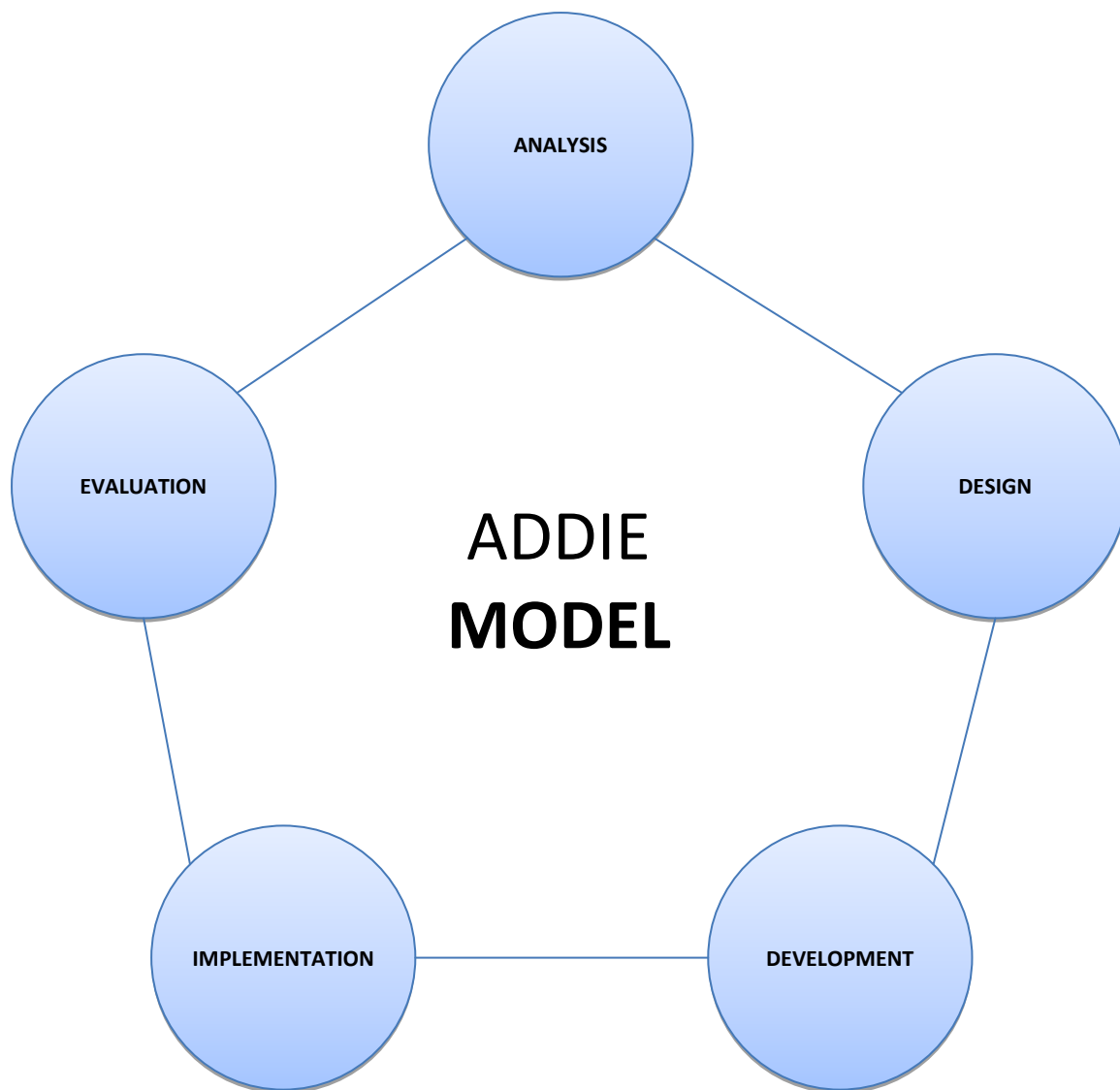


Figure 4.1: The ADDIE model (Training Industry, 2013)

Some critique against the ADDIE model is that it is too systematic or linear in its approach and that it is time-consuming in its implementation. However the systematic approach has several advantages when it comes to the creation of technology-based training, such as working in unity, rapid development of modules, programmers and designers work in agreement in respect of what learning activities are effective and it validates the creative process early on in the development cycle (Fardoun & Alghazzawi, 2012).

4.7.2. ELEARXML: A NEW E-LEARNING SYSTEM METHODOLOGY

Fardoun and Alghazzawi (2012) developed a new e-learning systems methodology based on various other existing methodologies. This methodology has been primarily based on the ADDIE model to provide a systematic approach to e-learning development and is called

eLearnXML. Their aim was to develop, what they coined, a Model-Based Development Environment (MB-ISDE) to overcome the limitations of traditional ISD methodologies. This was done to include e-learning development in the “current trends of mode-based software development.” They felt that the methods used to design e-learning systems was not mature enough and argued that e-learning content is being developed in Learning Content Management Systems and Learning Object Repositories (LORs). In their proposal they considered a user interface component, discoursing its importance and complexity, thus making it an important part of ISD.

Their final proposed model considered two cornerstones, namely: models and e-learning components (refer to section 3.7). They integrated these elements in a framework that provides a more homogenous ISD development environment.

4.7.3. AN E-LEARNING SYSTEMS ENGINEERING METHODOLOGY

Gilbert *et al.* (2005) wrote an article on e-learning systems engineering methodology, in which they propose a methodology to use in developing e-learning materials. Their methodology identified key stages and steps required for the development of e-learning resources and they based it on SSADM¹¹. They argued that it is useful to base their proposed methodology on a methodology that is familiar and well proven. They used SSADM to structure their SDM, depicted in Figure 4.2. There are six phases to the methodology (feasibility, analysis, design, construction, operation, and evaluation) and within these phases there are nine stages, underpinned by the continuous parallel procedures of project and quality management. They went on to described these stages and the different steps that make up the complete methodology. They reiterated the fact that there is a lack of research evidence for the actual application of such a methodology. The contribution such a methodology makes, is that it provides the LMS developer with an explicit structure and content to develop an e-learning project.

¹¹ SSADM: Structured Systems Analysis and Design Methodology

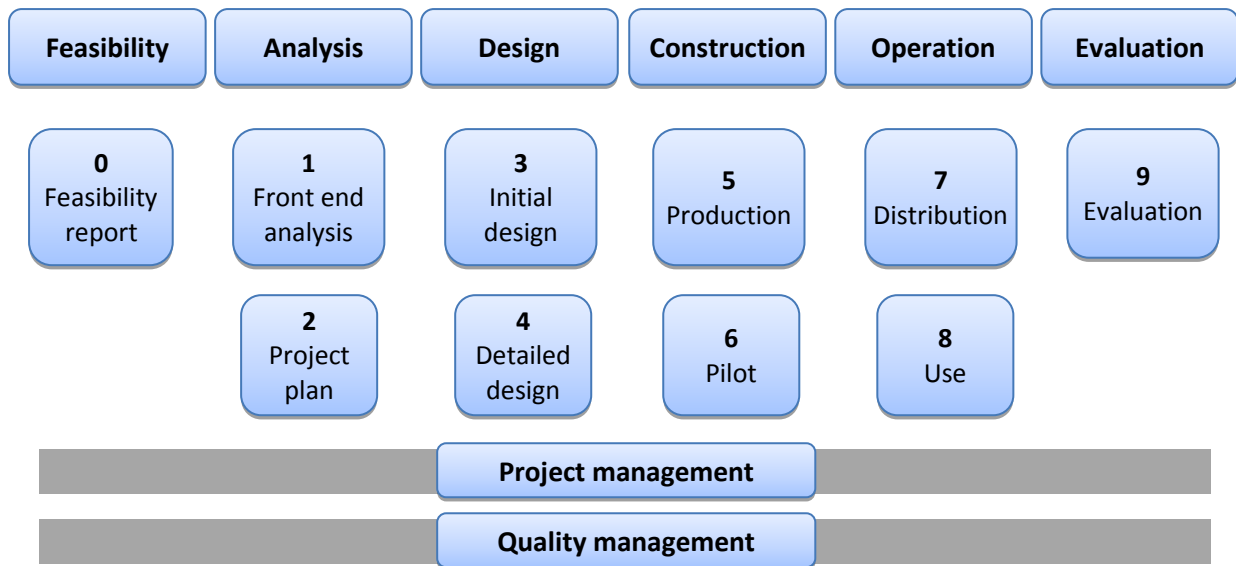


Figure 4.2: E-learning systems engineering methodology based on SSADM (Gilbert et al., 2005)

The aim of section 4.7 was to determine the existence of SDMs used for developing e-learning systems. Research did not find any commercially available SDM for developing LMSs, only methodologies for developing e-learning content, methods of course design and designs for e-learning. Many academic efforts have been made in the development of Instructional Systems Design models but far less into SDMs for e-learning systems. The reason for this could be that LMSs are not seen as a special kind of information system but as a web-based system that adheres to the development concerns associated with such systems. The measurement element (refer to section 5.2) will try and ascertain if the respondents share this belief.

4.8. CONCLUSION

This chapter gave a background of SDMs by discussing the classification of the different eras of methodologies, as well as the seven broad themes or approaches to SDMs.

Although the field of systems development methodologies is four decades old, there is still some contention as to the exact definition of SDMs as such. In section 4.3 the various definitions were discoursed and there was decided on a definition pertaining to this study.

There is clearly a lack of empirical research underpinning the use and effectiveness of SDMs. The evidence that could be found in the literature was summarised in sections 4.4 and 4.5.

The rest of the chapter focussed on SDMs for web-based systems (section 4.6) and also explored the literature for evidence of the existence of SDMs for e-learning systems (section 4.7). Although no commercial SDMs specifically for designing learning management systems could be found, we came across some academic efforts pertaining to this problem.

This chapter also touched on instructional systems design models being used to create learning content. Many of these models are described as systems development methodologies but are in fact models for designing learning content as opposed to actual systems development methodologies used to develop software systems.

In the next chapter, the questionnaire design and conceptual research model will be discussed.

CHAPTER 5

QUESTIONNAIRE DESIGN AND CONCEPTUAL RESEARCH MODEL

5.1. INTRODUCTION

The aim of this chapter is to develop a model that conceptualises the research questions and this will serve as a basis to determine the relationships that may or may not exist between the constructs¹². In section 5.2 the process that was followed in designing the questionnaire will be outlined. Section 5.3 will provide the conceptual research model. The chapter will be concluded in section 5.4 with a summary of the important aspects of the chapter.

5.2. QUESTIONNAIRE DESIGN

In section 2.5 it was established that questionnaires will be used as data generation method or measurement element. This section will discuss the design of the questionnaire under the following segment headings: development, operationalisation, distribution, validation and coding, data collection and response rate, constructs and measurements and some additional comments relating to the questionnaire.

5.2.1. DEVELOPMENT OF THE QUESTIONNAIRE

This questionnaire was developed after the literature review had been done in order to have better knowledge of what should be measured with a research study such as this.

The researchers developed the questionnaire in collaboration with Statistical Consultation Services, at the Potchefstroom Campus of the North-West University. They had input into the format of the questionnaire, in order to expedite data analysis, once the questionnaires were received.

¹² A construct (latent variable) can be defined as an explanatory variable which is not directly observable (Beck 1950).

Questionnaires should be relatively short, not taking more than 10 to 15 minutes to complete (Comley, 2002). This was taken into account with the design of this questionnaire.

5.2.2. OPERATIONALISATION OF THE QUESTIONNAIRE

To operationalise the identified constructs in a conceptual research model, a researcher must select the measurement scale items (i.e. measurement item questions) and scale types, and combine them in some form of measurement instrument (Caplan, 2002; Conradie, 2010). In this case the measurement instrument is a macro-enabled Excel-based questionnaire (refer to Addendum A).

The questionnaire contained three sections:

1. **Background:** To gather relevant background information on the respondents.
2. **The E-Learning System:** This section generated data on several aspects of the current e-learning systems the respondents use, including the procurement of the e-learning system, the e-learning platform, the effectiveness of the e-learning system, etc.
3. **Systems Development Methodologies:** This section tested how respondents felt about the use and efficiency of SDMs in developing e-learning systems.

Closed-ended questions were used, with certain options of the questions as open, to allow the respondents to elaborate.

The closed format-type questions used in the questionnaire will subsequently be listed. (See Table 5.1 for the wording and coding):

- **Leading questions.** With certain questions, the respondents were required to provide a particular type of answer, in order for the researchers to gather information on a certain issue.
- **Dichotomous questions.** This question type asks the respondents to answer only yes or no.
- **Likert scale questions.** Most of the questions used a five-point Likert scale to ascertain how strongly the respondents agree to certain statements.
- **Importance questions:** Two of the questions asked the respondents to rate the importance of particular issues on a rating scale of four points.

See Table 5.2 (in section 5.2.6) for a summary of the operationalisation of the constructs.

5.2.3. DISTRIBUTION OF THE QUESTIONNAIRE

Questionnaires were distributed to personnel at institutions of higher education in South Africa that are responsible for developing and/or deploying e-learning systems. Software companies in South Africa, which develop e-learning solutions, were also targeted.

The questionnaire was distributed electronically as a macro-enabled Excel file, which was automatically emailed back to the researchers of this study.

5.2.4. VALIDATION AND CODING

The questionnaire had extensive built-in entry validation to ensure that the respondents fill in the correct values. The respondents could only mark “x” or “X” in the appropriate cells, with all the other cells locked. The questionnaire also advanced automatically to the next section (or option) that respondents had to answer. Respondents were given information on what sections had not been completed and they were prompted to complete those sections. They were also informed when a specific section(s) had too many options marked. This worked really well in ensuring that the data were “clean” and as result manual input, with regard to data cleaning, was kept to the minimum.

Coding was built into the questionnaire and hidden so that respondents could not see or edit it. The coding scheme can be seen in Table 5.1.

Type of question	Coding value
Leading questions	Value of 1 – (n) number of options. For example: 1-4 or 1-5.
Dichotomous questions ¹³	1 for “Yes” 0 for “No”
Likert scale questions ¹⁴	1 for “Totally Disagree” 2 for “Disagree” 3 for “Neutral” e.g. neither “Agree” nor “Disagree” 4 for “Agree” 5 for “Totally Agree”
Importance questions	1 for “Not Important” or “Not At All” 2 for “Slightly Important” or “To Small Extent” 3 for “Important” or “To Large Extent” 4 for “Very Important” or “To Full Extent”

Table 5.1: Wording and coding scheme for the questionnaire

5.2.5. DATA COLLECTION AND RESPONSE RATE

All the universities in South Africa that present e-learning courses in some form or another were identified. In turn, the personnel responsible for the development and/or deployment of these e-learning systems at these universities were identified.

The private sector was also targeted. Companies that advertised themselves as developers of e-learning solutions were identified.

A total of 125 people from 35 institutions were contacted to participate in the study. They were contacted either telephonically or via email. The questionnaire, together with an explanation of the purpose and goals of the study, were e-mailed to potential respondents.

¹³ Refer to section 2.2.1 – nominal data.

¹⁴ Refer to section 2.2.1 – ordinal data.

Persons who were contacted, and did not return the questionnaire within two weeks, were sent reminders. A maximum of three reminders were sent to non-responsive persons before they were excluded from the study.

A response rate of 40% (or 50 questionnaires) was obtained. Although Nulty (2008) reports that the response rate for electronic or on-line surveys is lower than that of their paper-based counterparts, the response rate obtained with this questionnaire is still much higher than that of on-line survey averages, which is about 30%.

5.2.6. CONSTRUCTS AND MEASUREMENTS USED IN THE QUESTIONNAIRE

The questions and measurements used in the questionnaire will be summarised in Table 5.2 which will also serve as reference table for the rest of the study, as it provides a description of the different questions and measurements. This will hopefully make further reading easier. The first four questions were asked under the background section, questions five to eleven under the e-learning system section and the remainder under the systems development methodologies section. Refer to Addendum A for the complete questionnaire.

Question	Description of question or measurement	Abbreviation
1	Industry respondents work in	Industry
2	Was e-learning used for education or training at respondent's company	E-learning_Used_Education
3	Respondent's role or involvement with e-learning	Role
4	Number of users of respondent's LMS	Number_Users
5	Platform (open-source or proprietary) of respondent's LMS	Platform_Used
6	Procurement method used for LMS	Procurement_Method_LMS
7	Development of tools being utilised in respondents' LMS	Develop_Tools
8	On-line availability of LMS	Online_Availability
9	Perceived success of the LMS	Perceived_Success_LMS
10	Satisfaction of the LMS platform	Satisfaction_LMS_Platform
11	Importance of identified CSFs of e-learning to respondents	CSF_E-learning
12	The use of formal SDMs in developing LMSs or LMS tools	Formal_SDM_Use
13	Size of development team	Size_Dev_Team
14	To what extent were certain standard SDMs used	Extent_Standard_SDM
15	How stringent were SDMs used	Stringent_Use_SDM
16	Performance expectancy of the SDM and the perceived support that the SDM provides ¹⁵	Performance_Expectancy_SDM & Support_SDM_Provided
17	Perceived impact of the SDM on the quality & productivity of the systems development process	Impact_SDM_Quality_Productivity
18	Perceived impact of the SDM on the quality of the LMS	Impact_Quality_LMS
19	Willingness to use SDMs for future LMS projects	Willingness_SDM_Future
20	Reasons for not using SDMs	Not_Use_SDM
21	Respondent's opinion on the need for an SDM specifically for LMSs	Need_SDM_LMS

Table 5.2: Summary of questions and measurements

¹⁵ Factor analysis indicated that this question contained two factors (See Section 6.3.2.3).

5.2.7. SOME ADDITIONAL COMMENTS RELATING TO THE QUESTIONNAIRE

From the onset of this study the researchers knew that they were targeting a very niche population. Exactly just how small the population was quickly became apparent in the weeks following the launch of the survey.

On closer inspection of the population, it was found that many of the companies that advertise themselves as “E-learning developers” are in fact only developing learning solutions, based on procured e-learning systems. Thus they develop an end-to-end (electronic) learning solution that includes content development, content management, enrolment, administration, etc., but not actually the e-learning systems or LMSs as such.

A good many organisations disclosed to outsourcing the actual LMSs development to overseas companies and only developing e-learning content in South Africa. Table 5.3 will provide some comments that were received via email or telephone conversations from the respondents or candidate respondents. This will give an idea of the response received and serve as introduction to Chapter 6, the results of the statistical analyses, as well as clarify some of the reasons why the so called “E-learning developers” in South Africa are only content developers.

Industry or respondent	Comment
University 1	<ul style="list-style-type: none"> • “We are in the process of moving from Blackboard to Moodle.” • “We initially implemented Moodle only for our off-campus students, but after extensive testing we decided that an open-source platform, thus Moodle, serves our education model well.”
University 2	<ul style="list-style-type: none"> • “We used Blackboard’s Learn LMS but implemented Moodle a couple of years ago”
University 3	<ul style="list-style-type: none"> • “Yes, we are using an open-source LMS exclusively.”; “In our case, Moodle.”
University 4	<ul style="list-style-type: none"> • “Our university had a proprietary LMS, but many factors required us to consider an open-source LMS.” • Response to question on which factors: “Mostly the cost of maintaining our (proprietary) LMS. Sakai also helps with the modularity of our LMS. Tools can be enabled or disabled as need arises.”
University 5	<ul style="list-style-type: none"> • “I don’t think there is one university in SA that doesn’t use an open-

	source LMS.”
University 6	<ul style="list-style-type: none"> • “It is way too difficult and expensive to develop an LMS.”
Industry 1	<ul style="list-style-type: none"> • “We use Saba, which is an industry-leading (proprietary) LMS.” • Response to a question asked about in-house development: “No, we don’t do LMS development, however we build our own e-learning courses that we plug into Saba and it is then made available to our end-users.”
Industry 2	<ul style="list-style-type: none"> • “We will not easily consider an in-house developed LMS.” • Response to why not on above question: “It is too expensive to develop an LMS from the ground up; we’d rather customise the UI and give attention to existing tools.”
Industry 3	<ul style="list-style-type: none"> • “We maintain our (proprietary) LMS in-house and have made some customisations to it, but nothing drastic.”
Industry 4	<ul style="list-style-type: none"> • “I don’t think we will ever go for an in-house developed system.”
Industry 5	<ul style="list-style-type: none"> • “We have a complex in-house developed system used to train thousands of employees.”
Industry 6	<ul style="list-style-type: none"> • “We used experts in the field to do programming for us on specific tools we use in our (proprietary) LMS.”
Industry 7	<ul style="list-style-type: none"> • “We use Saba. It provides us with a large off-the-shelf content library that we purchase through content providers. We then deploy this content on Saba.”
Industry and academic	<ul style="list-style-type: none"> • “We consider ourselves ‘developers’, but in the sense that we develop e-Learning content (courses, assessments, etc.) but not systems.” • “No, we are only content developers.” • “We develop complete end-to-end learning solutions based on proprietary LMSs.” • “We develop the content that we plug-in to Blackboard.”

Table 5.3: Comments from various respondents on the development of LMSs

From Table 5.3 one can infer that the academic institutions advocate the use of open-source LMSs very strongly, while the private sector uses proprietary systems. There are also compelling statements regarding the in-house development of LMSs in that it is too

expensive, too much of an effort and not feasible enough for smaller companies or smaller projects. Many companies that market themselves as e-learning developers, only develops learning solutions or e-learning content and not complete LMS systems. Moodle and Sakai seems to be the biggest players in the open-source market and Saba and Blackboard in the proprietary market.

5.3. CONCEPTUAL RESEARCH MODEL

This study aims to explore and understand the factors that influence the use and effectiveness of SDMs in developing learning management systems. As such it can be viewed as exploratory research. However, the researchers will still try and prove the supposed influence, with statistical techniques, in Chapter 6 of this study.

With exploratory research the goal is to achieve new insights into specific occurrences by developing an exploratory model. This model is based on specific hypotheses or a research problem and is presented as a relationship between two constructs (Tull & Hawkins, 1987). These relationships will be based on the research questions.

This section will give an overview of how the research problem was approached in terms of conceptualising the research model. We will review the research questions given in section 1.3. Based on additional insights into the target population, from the questionnaires received, these research questions will be expanded on. This will serve as a basis for the development of a conceptual research model.

5.3.1. EXPANDED RESEARCH QUESTIONS

When one sets out with a research problem, one seldom has a complete picture of where the research will lead. As a research problem is disseminated into manageable parts, new ideas regarding how a problem should be approached, becomes apparent. As the questionnaire was developed the researchers realised that there are perhaps additional questions, and relationships between constructs that validate pursuing; from this then, the rationale for elaborating on the original research questions.

The original research questions (refer to section 1.3) and how it corresponds to the expanded research questions and the questionnaire questions and measurements (refer Table 5.2), will subsequently be tabulated in Table 5.4.

Nr.	Original research question (Section 1.3)	Question in measurement element that determines this (see Table 5.2)	How the original research question was expanded and corresponds to the new research questions (see list of expanded research questions below)
i	Are SDMs currently being used in developing e-learning systems?	Questionnaire questions: 12 & 14	New research questions: 8, 9
ii	If so, which SDMs are being used?	Questionnaire question: 14	New research questions: 8, 9
iii	Are the SDMs being used effectively?	Questionnaire questions: 9, 16, 17, 18, 19	New research questions: 10, 11, 12, 13, 14, 15, 16, 17, 18
iv	Is there a difference between the SDMs used for proprietary and open-source systems?	Questionnaire questions: 5, 14, 19, 20, 21	New research questions: 1, 2, 3, 4, 5, 6 & 7
v	How can a specific SDM be adapted to better suit e-learning systems?	Questionnaire questions: 20 & 21 and from the literature	New research questions: 19 & 20
vi	Can an SDM be developed to promote the changes of success for developing e-learning systems?	Questionnaire questions: 20 & 21 and from the literature	New research questions: 19 & 20

Table 5.4: Original research question as it relates to expanded research questions

This list of expanded research questions that were identified, whilst adhering to the original research questions, will subsequently be listed. (See Table 5.5 for a summary):

1. Is there a relationship between the industry in which the LMS is being utilised and the platform (open-source or proprietary) on which the LMS is built?
2. Is there a relationship between the industry in which the LMS is being utilised and the number of users of the LMS in question?
3. Is there a relationship between the industry in which the LMS is being utilised and the method of procurement of the LMS?
4. Is there a relationship between the platform of the LMS used and the perceived success of the LMS?
5. Is there a relationship between the platform of the LMS used and the satisfaction of the platform?
6. Is there a relationship between the procurement method of the LMS and the satisfaction of the platform used?
7. Is there a relationship between the perceived success of the LMS and the satisfaction of the platform used?
8. Are formal SDMs being used in the development of LMSs?
9. If so, which formal SDMs are being used in the development of LMSs?
10. Is there a relationship between the type of formal standard SDM used and the perceived success of the LMS?
11. Is there a relationship between the type of formal standard SDM used and the impact of the SDM on the quality and productivity of the development process?

12. Is there a relationship between the performance expectancy of the SDM and the impact of the SDM on the quality and productivity of the development process?
13. Is there a relationship between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS?
14. Is there a relationship between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process?
15. Is there a relationship between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS?
16. Is there a relationship between the impact of the SDM on the quality and productivity of the development process and the perceived success of the LMS?
17. Is there a relationship between the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS?
18. Is there a relationship between the perceived impact of the SDM on the quality of the LMS and the perceived success of the LMS?
19. Is there a relationship between the need to design an SDM specific to LMS development and the perceived success (or lack of) of the current LMS used?
20. Is there a relationship between the need to design an SDM specific to LMS development and the SDM that was used to design the current LMS?

The statistical analysis, discussed in Chapter 6, will be based on the expanded list of research questions.

5.3.2. CONCEPTUAL MODEL

This section will summarise the expanded research questions and the relationships that will be tested in Table 5.5, and provide the conceptual research model in Figure 5.1.

Research Question	Relationship to test
RQ1	Industry → Platform_Used
RQ2	Industry → Number_Users
RQ3	Industry → Procurement_LMS
RQ4	Platform_Used → Success LMS
RQ5	Platform_Used → Satisfaction_LMS_Platform
RQ6	Procurement_LMS → Satisfaction_LMS_Platform
RQ7	Success LMS → Satisfaction_LMS_Platform
RQ8	Formal SDM Use
RQ9	Extent_Standard_SDM
RQ10	Formal_SDM_Use → Success_LMS
RQ11	Extent_Standard_SDM → Impact_SDM_Quality_Productivity
RQ12	Performance Expectancy SDM → Impact_SDM_Quality_Productivity
RQ13	Performance Expectancy SDM → Impact_Quality_LMS
RQ14	Perceived Support SDM → Impact_SDM_Quality_Productivity
RQ15	Perceived Support SDM → Impact_Quality_LMS
RQ16	Impact_SDM_Quality_Productivity → Success LMS
RQ17	Impact_SDM_Quality_Productivity → Impact_Quality_LMS
RQ18	Impact_Quality_LMS → Success LMS
RQ19	Need_SDM_LMS → Success_LMS
RQ20	Need_SDM_LMS → Extent_Standard_SDM

Table 5.5: Summary of research question and relationships that will be tested

According to Asher (1983) a conceptual model can guide research by providing a visual representation of theoretical constructs (and variables) pertaining to a study. The first step is a thorough review of the literature.

To visualise the research questions that this study aims to answer, a conceptual research model was drafted. The conceptual model (Figure 5.1) was derived from the research questions and the relationships tabulated in Table 5.5.

- The first construct in the model is “Industry” and it was also the first question of the questionnaire. The industry supposedly could have an influence on (or relationship with) the LMS platform (open-source or proprietary) that is being used, the number of learners or students using the LMS and also the LMS procurement method applied.
- The LMS procurement method and perceived LMS success could determine the user satisfaction of the LMS platform that is being used.
- Both the LMS platform and LMS procurement method could have an influence on the perceived success of the LMS.
- If a formal SDM is used it can perhaps influence the perceived success of the LMS.
- The need that exists for an SDM designed specifically for developing LMSs can perhaps have an influence on the perceived LMS success.
- The extent to which standard SDMs are being utilised in LMS development could have an influence in the perceived LMS success.
- The extent to which standard SDMs are being used could influence the impact the SDM has on the quality and productivity of the development process.
- The expectancy developers have of their SDM could influence the impact the SDM has on the quality and productivity of the development process, as well as the impact the SDM has on the quality of the LMS.
- The impact the SDM has on the quality and productivity of the development process can have an influence on the willingness developers have to use SDMs in the future, as well as an effect on the impact an SDM can have on the quality of the LMS.
- The perceived support an SDM provides in the development of systems can perhaps have an effect on the impact the SDM has on the quality and productivity of the development process as well as an effect on the impact an SDM can have on the quality of the LMS.

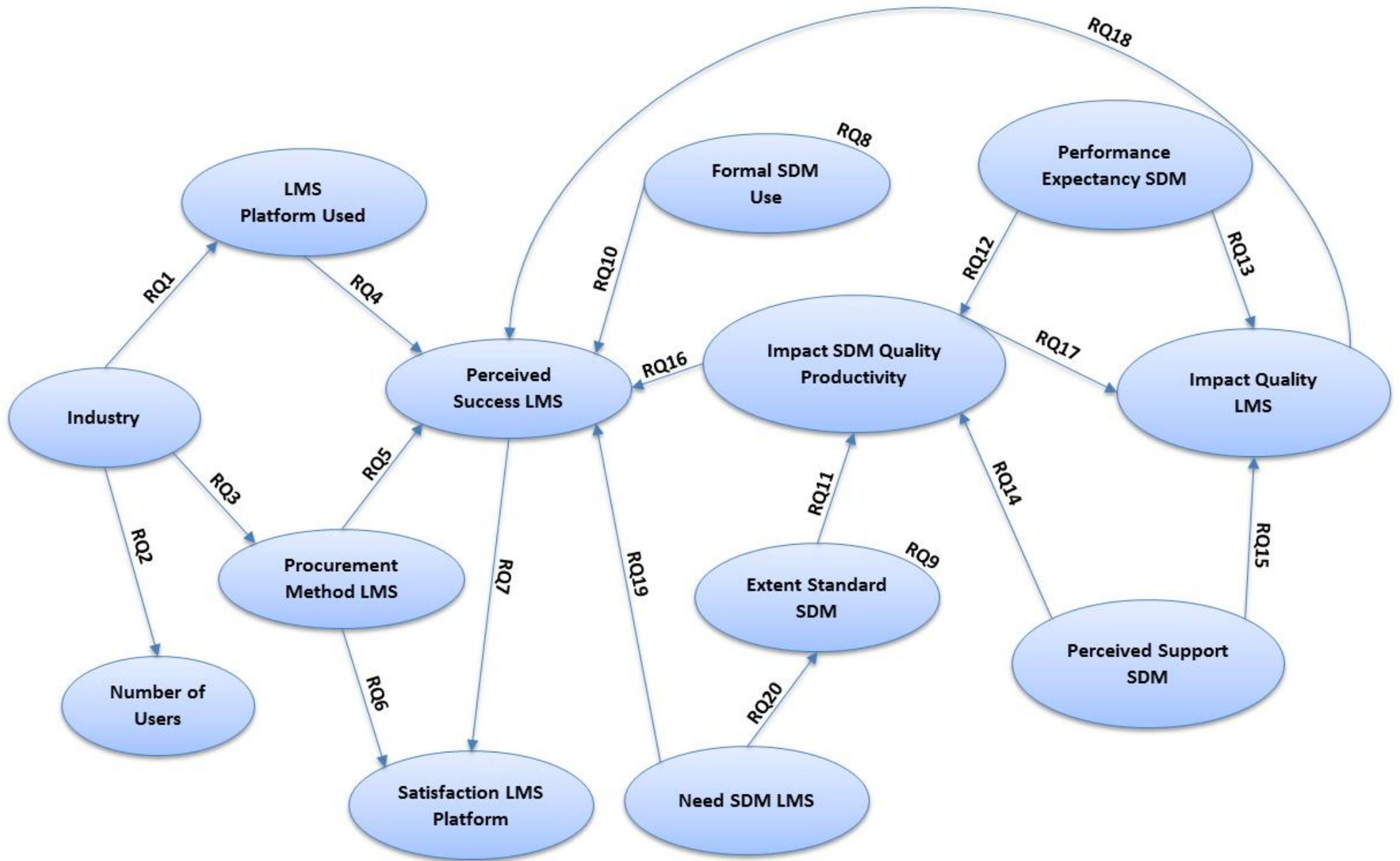


Figure 5.1: Conceptual research model

5.4. CONCLUSION

This chapter discussed how the measurement element of this study, a questionnaire, was designed, how and why the research questions were expanded on and also provided a basis for the rest of the study, in developing a conceptual research model.

The questionnaire was developed with assistance from Statistical Consultation Services, at the Potchefstroom Campus of the North-West University. It was concise and relevant and contained mostly leading, importance and Likert scale questions. It had built-in coding and validation to ensure that the minimum manual input was required when converting the questionnaires to a dataset. The questionnaire was distributed to both academic institutions and the private sector. A response rate of 40% (or 50 questionnaires) was obtained, which is well above the acceptable response rate for electronic surveys. Constructs and measurements were defined from the questions asked (see Table 5.2). Some of the comments received from the respondents and candidate respondents were summarised in Table 5.3.

As the study progressed it was clear that the initial research questions (refer to section 1.3), although still of importance, were too concise to accomplish the research aim. It was decided to expand the research questions, whilst still adhering to the original research objectives. This was done in section 5.3.1 and summarised in Table 5.4. The statistical analyses that will be done in Chapter 6 will be based on the 20 new research questions that were defined.

A model that conceptualises the research questions was also developed and the possible relationships between the constructs were conferred (refer to Figure 5.1). This will serve as a basis to determine the relationships that may or may not exist between the constructs.

In the next chapter, the results of the statistical analyses will be discussed.

CHAPTER 6

RESULTS OF THE STATISTICAL ANALYSES

6.1. INTRODUCTION

This chapter will reflect the results of the statistical analyses that were carried out on the data. The descriptive statistical analysis that was applied will be discussed in section 6.2 and will be concluded by a discussion and final comments on the analysis. The inferential statistical analysis will be reflected in section 6.3 where the researchers will try and answer the expanded research questions listed in section 5.3.1. This chapter will be concluded by a discussion and final comments.

6.2. DESCRIPTIVE STATISTICAL ANALYSIS

This section will provide details on the descriptive statistics that were performed on the data. The descriptive statistics will be discussed under the headings used in the questionnaire, namely: background information, the e-learning system and systems development methodologies.

Some additional information on the response rate, data screening and cleaning and further coding that were needed for the dataset, will serve as introduction to the descriptive analysis.

Response rate

Fifty responses were received from a possible one hundred and twenty-five responses. Therefore, the participation rate equalled 40% with 50 cases available for data analysis.

Data screening and cleaning

The data was inspected for missing data. As result of the built-in validation, very few missing entries were found. With the ones that were found, the respondents indicated that the question, or section of questions, did not apply to their expertise. After data collection, questionnaires were locked into an Excel workbook and no manual input was required with the questionnaires themselves, in order to ensure data integrity.

Further coding

Even with built-in coding in the questionnaire, further coding had to be done. After the cut-off date, all the questionnaires were combined in an Excel workbook with each respondent's questionnaire as a separate Excel worksheet. Formulas were used to compile the summational data in a separate worksheet. Formulas were also used to get the dataset in a format compatible with SPSS¹⁶.

The following three sections will discuss the results of the descriptive statistical analysis. Refer to Table 5.2 (section 5.2.6) for a summary of the questionnaire and Addendum A for the complete questionnaire.

6.2.1. BACKGROUND INFORMATION

This segment gives a summary of the background information of all the respondents that completed the survey.

6.2.1.1. INDUSTRY THE RESPONDENTS WORK IN

Just fewer than 60% of the respondents stated that the type of industry they work in can be described as "Academic". The rest (40.43%) were in the "Private Sector". See Figure 6.1.

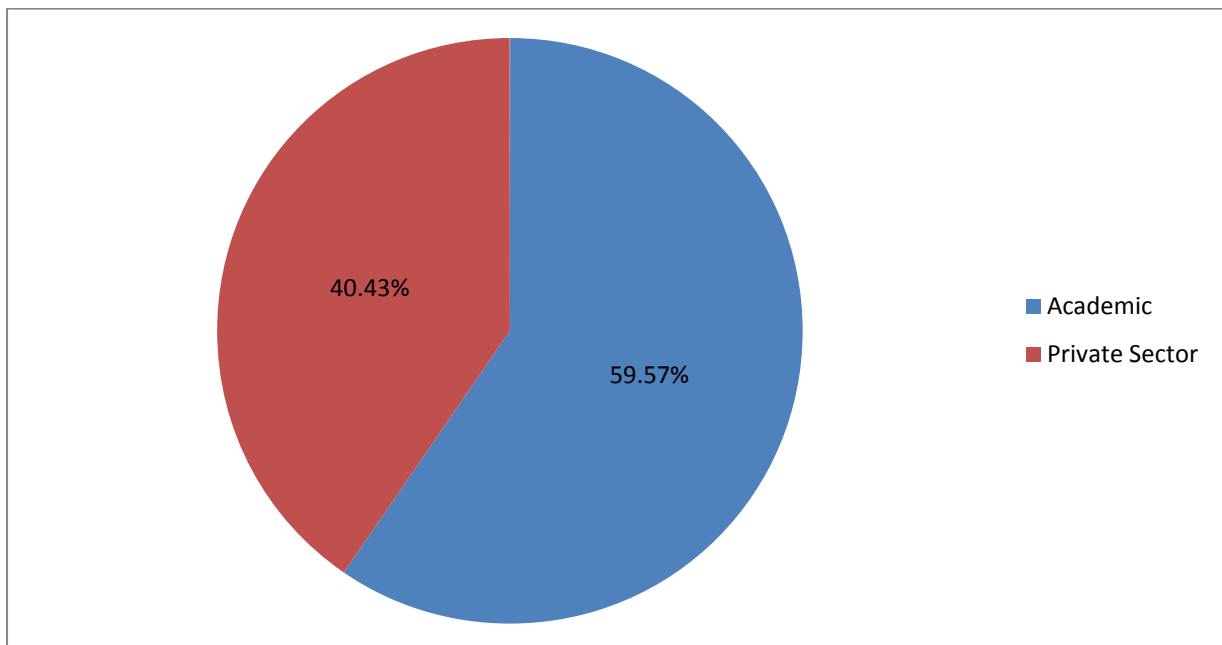


Figure 6.1: Industry the respondents work in

¹⁶ SPSS is a software package used for statistical analysis.

6.2.1.2. E-LEARNING USE FOR EDUCATIONAL PURPOSES

Just over 93% of the respondents stated that they use e-learning for educational or training purposes, with about 7% of respondents indicating they do not use e-learning in their organisation. This portion was selected exclusively by software houses that develop e-learning systems, but do not use it to train their own employees. See Figure 6.2.

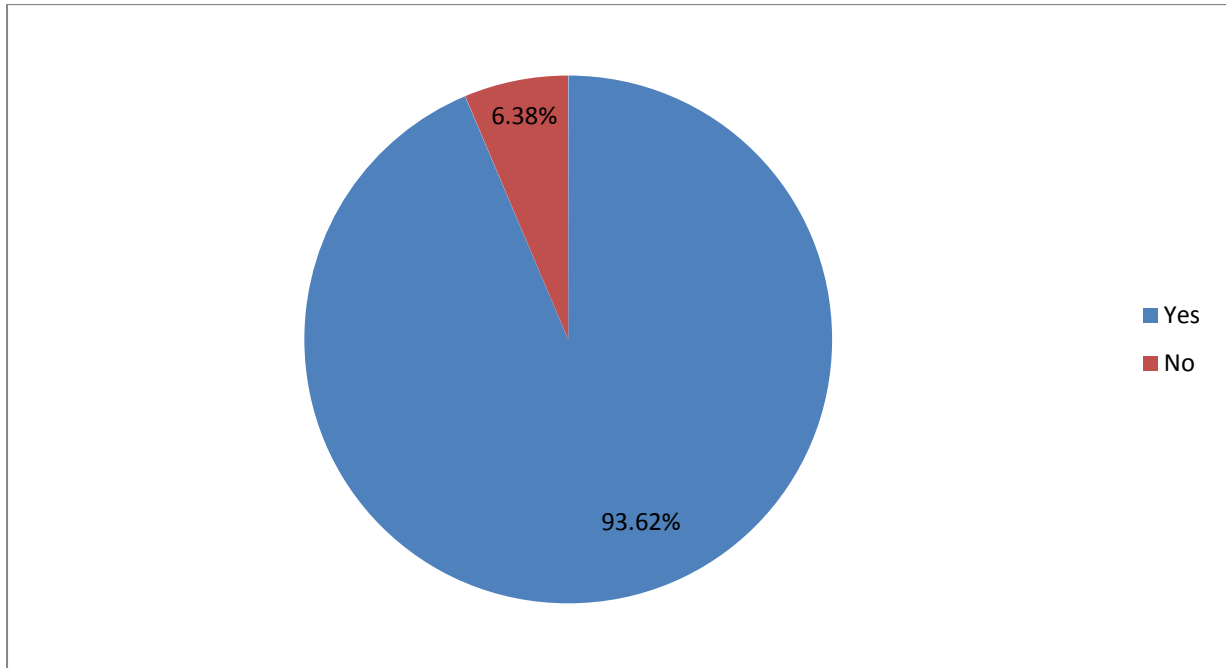


Figure 6.2: E-learning use for educational purposes

6.2.1.3. RESPONDENTS' INVOLVEMENT WITH E-LEARNING

The respondents had to select the roles they perform in their organisation, regarding e-learning. They could choose more than one option. For example, a respondent could choose the developer role, as well as the role of project leader or project member. The frequency of choices leaned towards the "Developer" and "Project Leader" roles. More than 22% of the respondents indicated that they had a developer involvement with e-learning and more than 17% had a project leader involvement. It is important to note that respondents could choose multiple roles and thus a developer could, for instance easily also be a project member or project leader. Of the 50 respondents a total of 109 roles were selected which gives an average of 2.18 roles per respondent. The distribution of this question can be seen in Figure 6.3.

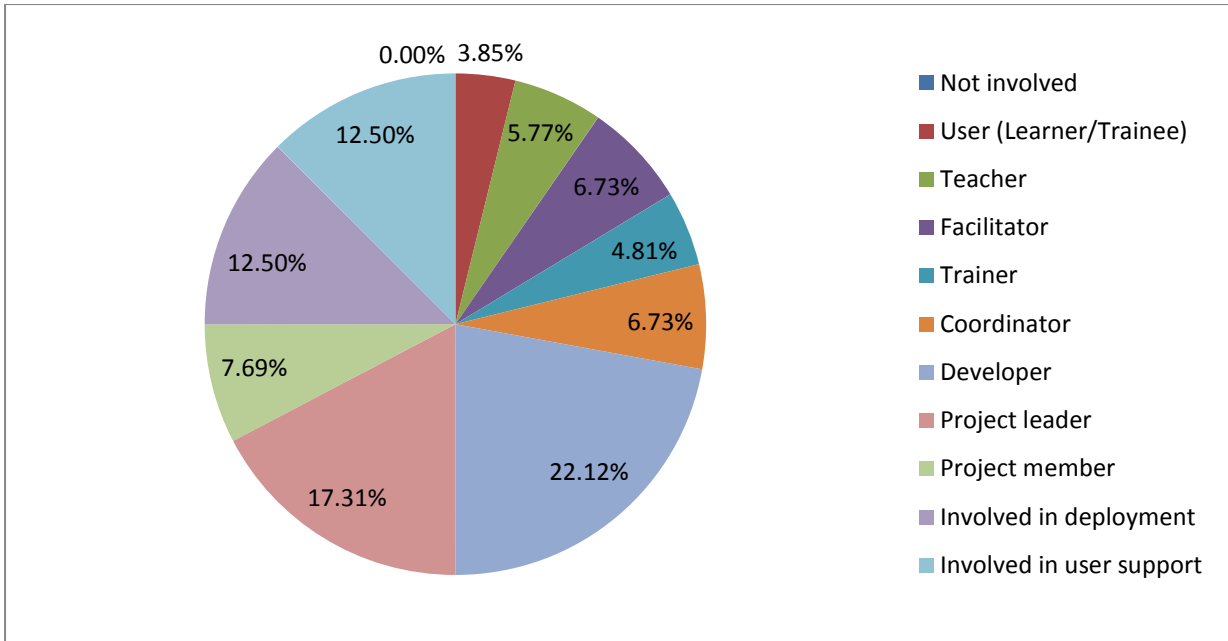


Figure 6.3: Respondents involvement with e-learning

6.2.1.4. NUMBER OF LEARNERS, STUDENTS OR EMPLOYEES

The respondents were asked to indicate the number of learners, students or employees that are using their e-learning system, with almost 58% of the LMSs being used to train or educate 10 000 or more people. It is clear that LMSs are used to deploy e-learning on a large scale. See Figure 6.4.

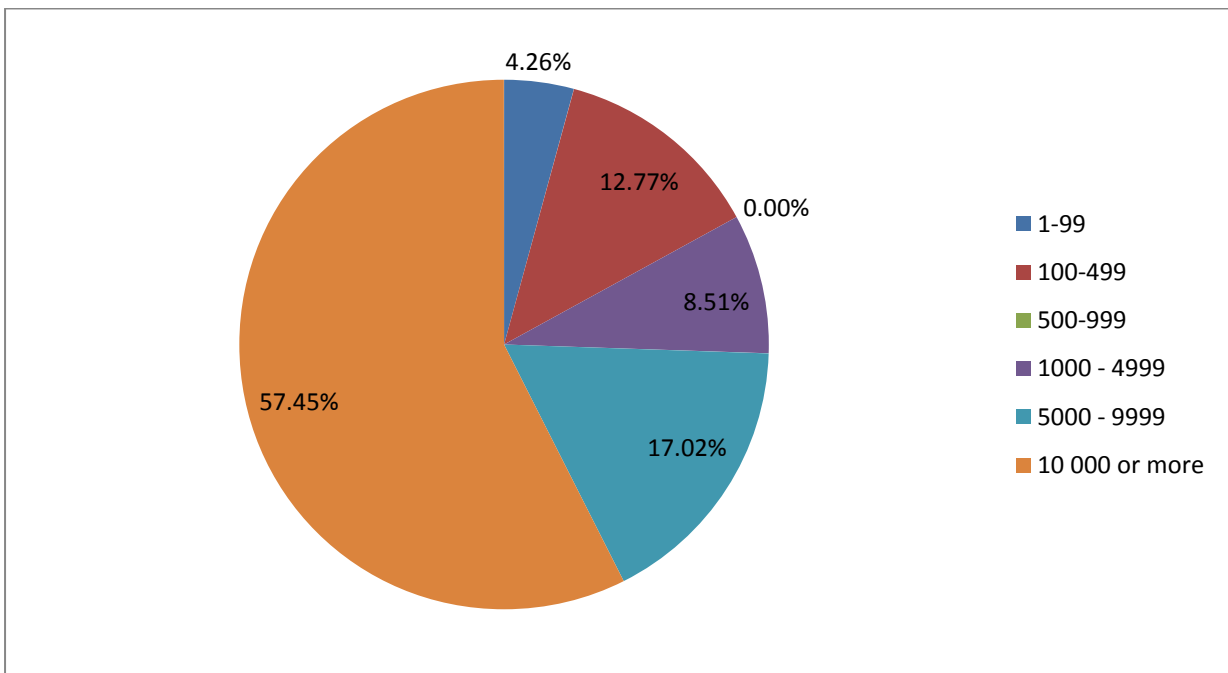


Figure 6.4: Number of users of the LMS

6.2.2. THE E-LEARNING SYSTEM

This section will confer the descriptive statistics for section two of the questionnaire, which measured the respondents' perception on certain aspects of their e-learning systems or LMSs. All of the respondents were able to complete this section.

This section will use colour scales to indicate the frequency of the specific variables, with red the most and green the least frequent.

6.2.2.1. LMS PLATFORM

Respondents were prompted to indicate if they use a proprietary or an open-source LMS, with almost 60% using an open-source LMS environment. See Table 6.1.

LMS environment	Percentage
Proprietary	42.55%
Open-source	57.45%

Table 6.1: LMS platform

6.2.2.2. PROCUREMENT METHOD OF LMS

The question regarding the LMS platform (refer to section 6.2.2.1) was broken down further into four procurement methods of LMSs. Respondents were asked whether they: purchased, developed in-house, outsourced, use an open-source (as-is) or adapted from an open-source LMS. Just fewer than 32% of the respondents indicated that they adapted their current LMS from an open-source based LMS. See Table 6.2.

Procurement method	Percentage
Purchased	23.40%
Developed in-house	17.02%
Outsourced	2.13%
Open-source (used as-is), specify which:	25.53%
Adapted from open-source system, specify which:	31.91%

Table 6.2: Procurement method of LMS

6.2.2.3. DEVELOPMENT OF TOOLS IN CASE OF OPEN-SOURCE

Respondents were asked to indicate whether they developed tools for their LMS, in case the LMS platform (refer to section 6.2.2.1) was indicated as an open-source system. One can see that just more than 40% indicated that they actually develop(ed) tools for an open-source LMS. See Table 6.3.

Tool development	Percentage
Yes	40.43%
No	42.55%
Not sure	17.02%

Table 6.3: Tool development for open-source LMSs

6.2.2.4. ON-LINE AVAILABILITY OF LMS

Interestingly enough, a little over 20% of the respondents indicated that their LMS was only available within the intranet of their organisation. See Table 6.4.

On-line availability	Percentage
Available on-line for access outside your organisation	78.72%
Available only within the intranet of the organisation	21.28%

Table 6.4: On-line availability of LMS

6.2.2.5. PERCEIVED SUCCESS OF THE LMS

Respondents were asked to what extent they agree on statements regarding their current LMS. An overwhelming 84.91%¹⁷ of the respondents answered in the affirmative, by marking either “Agree” or “Totally Agree”, on the different options of this question. See Table 6.5.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
The system is functional	0.00%	0.00%	4.26%	53.19%	42.55%
The system is reliable	0.00%	6.38%	6.38%	42.55%	44.68%
The system is maintainable	0.00%	4.26%	4.26%	42.55%	48.94%
The system is portable	0.00%	2.13%	25.53%	42.55%	29.79%
The system is efficient	0.00%	6.38%	8.51%	42.55%	42.55%
The system is usable	0.00%	0.00%	8.51%	42.55%	48.94%
The developed system meets user needs	2.13%	2.13%	10.64%	53.19%	31.91%
The documentation of the developed system is good	6.38%	14.89%	12.77%	36.17%	29.79%
Overall, the developed system is of high quality	2.13%	2.13%	12.77%	38.30%	44.68%
Overall, the users are satisfied with the developed system	0.00%	2.13%	12.77%	53.19%	31.91%
Overall, the developed system is a success	0.00%	4.26%	4.26%	55.32%	36.17%

Table 6.5: Perceived success of LMS

6.2.2.6. SATISFACTION WITH THE LMS PLATFORM

To statements regarding the e-learning platform, 44.68% of the respondents agreed that they were satisfied with their current platform and 29.79% totally agree to being satisfied with their platform. Almost 62% of the respondents would consider using an open-source LMS environment for future projects and 46.81% “Disagree” or “Totally Disagree” about considering in-house development for future LMS projects. Respondents were fairly neutral

¹⁷ This percentage was calculated by adding the Agree and Totally Agree columns and averaging it for all the variables across the complete question.

to purchasing a proprietary LMS for future projects and very few totally agreed or totally disagreed with that statement. See Table 6.6.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
I'm totally satisfied with our current platform	4.26%	6.38%	14.89%	44.68%	29.79%
I would consider using an open-source e-learning system for future projects	6.38%	12.77%	19.15%	27.66%	34.04%
I would consider purchasing a proprietary e-learning system for future projects	12.77%	23.40%	29.79%	23.40%	10.64%
I would consider the in-house development of an e-learning system for future projects	27.66%	19.15%	19.15%	17.02%	17.02%

Table 6.6: LMS platform satisfaction and procurement for future LMS projects

6.2.2.7. IMPORTANCE OF IDENTIFIED CSFS OF E-LEARNING

Respondents were asked to rate the critical success factors of e-learning systems in terms of importance. More than 72% of the respondents indicated technology as a “Very Important” factor. See Table 6.7.

Factor	Percentage			
	Not Important	Slightly Important	Important	Very Important
Instructor Involvement	4.26%	6.38%	38.30%	51.06%
Student Computer Competency	0.00%	6.38%	57.45%	36.17%
Student Collaboration	4.26%	17.02%	42.55%	36.17%
E-learning Course Content and Design	0.00%	6.38%	53.19%	40.43%
Technology	0.00%	2.13%	25.53%	72.34%
University/Company support to e-learning initiatives	0.00%	10.64%	40.43%	48.94%
E-Learning Usage Factor	4.26%	14.89%	53.19%	27.66%

Table 6.7: Importance of CSFs of e-learning systems to respondents

6.2.3. SYSTEMS DEVELOPMENT METHODOLOGIES

This section will confer the descriptive statistics for section three of the questionnaire. The bulk of the questionnaire was on systems development methodologies and the effect it has on e-learning systems. 25% of the respondents indicated that they were unable to complete this section, as they were either not involved with development or had little or no knowledge of SDMs. Thus the averages given for this section of the questionnaire are only calculated on the 75% of respondents that did complete this section.

This section will use colour scales to indicate the frequency of the specific variables, with red the most and green the least frequent.

6.2.3.1. THE USE OF FORMAL SDMS

Respondents were asked to indicate whether they used *formal* systems development methodologies to aid in systems development. Almost 80% indicated that they use formal SDMs in development. One has to take note that this section was on SDM use in LMS development. Thus, respondents answering this section are familiar with SDMs. See Table 6.8.

Formal SDM use	Percentage
Yes	79.41%
No	20.59%

Table 6.8: Formal SDM use

6.2.3.2. SIZE OF DEVELOPMENT TEAMS

More than 50% of the respondents indicated that the development teams they worked on consisted of between one and five staff members. See Table 6.9.

Amount of staff	Percentage
1-5	58.82%
6-10	17.65%
11-20	20.59%
21 or more	2.94%

Table 6.9: Number of staff members on development teams

6.2.3.3. TO WHAT EXTENT WERE STANDARD SDMS USED

On the question that asked respondents to indicate which SDMs they use and to what extent, Object-Oriented Analysis (OOA) and Rapid Application Development (RAD) were most frequently selected, with 47.06% and 38.24% of the respondents respectively, using it to a large extent. See Table 6.10.

SDM Used	Percentage			
	Not At All	To Small Extent	To Large Extent	To Full Extent
STRADIS (Structured Analysis, Design & Implementation of Information Systems)	47.06%	23.53%	23.53%	5.88%
OOA (Object-oriented Analysis)	14.71%	35.29%	47.06%	2.94%
RUP (Rational Unified Process)	70.59%	23.53%	5.88%	0.00%
XP (Extreme Programming)	52.94%	29.41%	14.71%	2.94%
RAD (Rapid Application Development)	35.29%	23.53%	38.24%	2.94%
ETHICS (Effective Technical & Human Implementation of Computer-based Systems)	85.29%	8.82%	2.94%	2.94%
IE (Information Engineering)	47.06%	38.24%	11.76%	2.94%
SSM (Soft Systems Methodology)	76.47%	17.65%	5.88%	0.00%
Other, specify:	76.47%	2.94%	17.65%	2.94%

Table 6.10: SDMs used in LMS development

6.2.3.4. STRINGENT USE OF SDMS

Almost 60% of the respondents indicated that they adapted the SDM they used, depending on the specific project requirements. See Table 6.11.

Stringent use of SDM	Percentage
As a general guideline only	35.29%
Adapted it depending on the project	58.82%
Implemented it rigorously	5.88%

Table 6.11: Stringent use of SDM

6.2.3.5. PERFORMANCE EXPECTANCY AND PERCEIVED SUPPORT OF THE SDM

The respondents were generally positive on the use, functionality and benefits of SDMs as can be seen in Table 6.12. Some of the noteworthy facts that can be highlighted on this question will subsequently be listed:

- Almost 80% of the respondents answered in the affirmative that it is recommended in their organisation to use SDMs on projects.
- About 75% were positive (Agree and Totally Agree) that one can see the results of using SDMs.
- More than 85% of the respondents felt positive (Agree and Totally Agree) that SDMs are beneficial to their projects.
- About 75% of the respondents were positive (Agree and Totally Agree) that they had greater control over their development work by using SDMs.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
Using an SDM is recommended in my work	0.00%	0.00%	20.59%	58.82%	20.59%
The result of using an SDM is clear to me	2.94%	2.94%	20.59%	41.18%	32.35%
I would be able to communicate to others the consequences of using an SDM	2.94%	11.76%	17.65%	55.88%	11.76%
I would be able to explain why using an SDM may or may not be beneficial	8.82%	0.00%	20.59%	52.94%	17.65%
The application of the SDM is clear to me	8.82%	8.82%	14.71%	52.94%	14.71%
The benefits of using the SDM is apparent	5.88%	2.94%	5.88%	58.82%	26.47%
Overall, I believe the SDM is user-friendly and easy to apply	2.94%	5.88%	26.47%	61.76%	2.94%
The SDM enable me to complete tasks quicker	2.94%	2.94%	35.29%	44.12%	14.71%
The quality of my work is improved by using the SDM	2.94%	0.00%	20.59%	52.94%	23.53%
It is easier to accomplish my work by using the SDM	2.94%	2.94%	29.41%	47.06%	17.65%
The effectiveness of my work in systems development was enhanced using an SDM	2.94%	2.94%	41.18%	38.24%	14.71%
I had greater control over my development work when using an SDM	2.94%	0.00%	20.59%	61.76%	14.71%
The SDM is compatible with my development work	2.94%	2.94%	26.47%	58.82%	8.82%
The SDM fits well in the way I like to work	5.88%	0.00%	26.47%	52.94%	14.71%
I was permitted to use the SDM on a trial basis to see what it can do	11.76%	5.88%	26.47%	50.00%	5.88%

Table 6.12: Performance expectancy of the SDM and perceived SDM support

6.2.3.6. PERCEIVED IMPACT OF THE SDM ON THE DEVELOPMENT PROCESS

The next question asked the respondents' views on the effectiveness of the SDM(s) they used in general. More than 67%¹⁸ answered in the affirmative regarding statements on the effectiveness of SDMs. See Table 6.13.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
The SDM was effective in the design process of the proposed system	2.94%	8.82%	29.41%	50.00%	8.82%
The SDM was effective in implementing the developed system	2.94%	0.00%	20.59%	58.82%	17.65%
The SDM was effective in testing the developed system	2.94%	2.94%	29.41%	61.76%	2.94%
The SDM was effective in reuse of components developed in previous systems	2.94%	11.76%	17.65%	58.82%	8.82%
The SDM helped to get the developed system accepted	2.94%	0.00%	26.47%	55.88%	14.71%

Table 6.13: SDM impact on the development process

6.2.3.7. PERCEIVED IMPACT OF THE SDM ON THE LMS

The respondents were asked to indicate whether they agree with statements regarding the effect SDMs had on their e-learning system in terms of functionality, reliability, maintainability, efficiency, quality, usability and user satisfaction. Notably, about 56% of the respondents agreed and about 12% totally agreed that the e-learning system was more reliable as result of using an SDM in development. 32.35% of the respondents were neutral on this statement. On average, 58%¹⁹ of the respondents indicated that they "Agree" or "Totally Agree" that their developed e-learning system was more functional, reliable, maintainable, efficient, of better quality, more usable and that users are more satisfied with the e-learning system, as result of using SDMs to develop the system. See Table 6.14.

¹⁸ This percentage was calculated by adding the Agree and Totally Agree columns and averaging it for all the variables across the complete question.

¹⁹ This percentage was calculated by adding the Agree and Totally Agree columns and averaging it for all the variables across the complete question.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
The e-learning system is more functional as result of using the SDM	0.00%	0.00%	44.12%	41.18%	14.71%
The e-learning system is more reliable as result of using the SDM	0.00%	0.00%	32.35%	55.88%	11.76%
The e-learning system is more maintainable as result of using the SDM	0.00%	0.00%	32.35%	41.18%	26.47%
The e-learning system is more efficient as result of using the SDM	0.00%	0.00%	47.06%	38.24%	14.71%
The e-learning system is of better quality as result of using the SDM	0.00%	2.94%	35.29%	50.00%	11.76%
The e-learning system is more useable as result of using the SDM	0.00%	0.00%	47.06%	35.29%	17.65%
The users of the e-learning system is more satisfied as result of using the SDM	0.00%	2.94%	50.00%	35.29%	11.76%

Table 6.14: Impact of SDM on LMS

6.2.3.8. WILLINGNESS TO USE SDMS FOR FUTURE PROJECTS

The respondents were asked their opinion on the use of SDMs for future projects. Almost 75% indicated that they would adapt the SDM(s) they use to suit the needs of the project as reflected in Table 6.15.

Statement	Percentage
Will use it again, as is	2.94%
Will adapt it to suit the needs of the project	73.53%
Will supplement it with other methodologies	11.76%
Will replace it with a better suited methodology	0.00%
Will not use a system development methodology again	0.00%
Other, please specify:	11.76%

Table 6.15: Future use of SDMs to develop LMS

6.2.3.9. REASONS FOR NOT USING SDMS

The next question tried to ascertain the reasons for not using SDMs. The question was stated negatively in order to determine if the respondents were actually answering the questionnaire truthfully. One can clearly see, in Table 6.16, that many of the answers shifted

to the “Disagree” and “Totally Disagree” side of the Likert scale, whereas in previous questions the opposite was the case. Some of the noteworthy facts that can be highlighted on this question include:

- It appears that organisations require the use of SDMs in development work, with more than 75% of the respondents answering in the affirmative that SDMs are required in their work.
- Almost 65% of the respondents disagreed and almost 9% totally disagreed that the benefits of SDMs are not extensive enough.
- More than 55% of the respondents disagreed with the statement that SDMs are too complex to use.
- More than 60% of the respondents confirmed (Agree and Totally Agree) that there was a lack of staff experienced in implementing SDMs in their development work.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
My organisation/IS department doesn't require the use of SDMs	26.47%	50.00%	0.00%	14.71%	8.82%
SDMs are complex or difficult to use	14.71%	55.88%	23.53%	5.88%	0.00%
Our current processes for development are adequate	2.94%	29.41%	23.53%	44.12%	0.00%
The benefits of using SDMs are not extensive enough	8.82%	64.71%	23.53%	2.94%	0.00%
The initial cost of procuring an SDM are high	14.71%	41.18%	32.35%	11.76%	0.00%
There is a lack of staff experienced in SDMs to implement such a strategy	5.88%	23.53%	8.82%	58.82%	2.94%
There is a lack of management support for the use of SDMs	5.88%	14.71%	41.18%	23.53%	14.71%

Table 6.16: Reasons for the non-use of SDMs

6.2.3.10. THE NEED FOR AN LMS-SPECIFIC SDM

With the last question of the questionnaire the researchers wanted to ascertain, by means of certain statements, if there was room for a newly developed SDM designed specifically for e-learning systems. See Table 6.17. Almost 75% of the respondents agreed that there was room for a newly designed SDM for developing LMSs. Almost all the respondents felt that e-learning systems could benefit from using an SDM. More than half of the respondents'

responses were neutral to the statement that e-learning systems are a special type of information system.

Statement	Percentage				
	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
There is room for a newly designed SDM specifically for developing e-learning systems	2.94%	11.76%	11.76%	73.53%	0.00%
An existing SDM can be adequately adapted to suit the needs of e-learning	2.94%	2.94%	44.12%	50.00%	0.00%
E-learning systems are a special type of IS and requires an unique SDM	8.82%	11.76%	55.88%	23.53%	0.00%
E-learning systems can benefit from using an SDM	0.00%	0.00%	14.71%	61.76%	23.53%

Table 6.17: The need for a new LMS-specific SDM

6.2.4. DISCUSSION AND FINAL COMMENTS ON DESCRIPTIVE STATISTICS

The descriptive statistics that are presented in this section reveal some interesting facts about learning management systems in South Africa and the use of systems development methodologies when developing LMSs.

Open-source LMSs are used more than proprietary LMSs and in section 6.3.3 the variance of use, between academic institutions and the private sector, will be examined. The user-base of these LMSs is quite large, with more than half of these systems being used to educate 10 000 or more people.

Overall, the respondents are of the impression that the quality of their LMSs are high and that SDMs are effective in developing LMSs. It also seems that respondents are aware of the benefits that SDMs have to offer and that SDMs are required, or at the very least recommended, in their development work. Respondents are generally very positive towards the use of SDMs and disagree that it may be too difficult or too expensive to implement.

Respondents feel that there may be room for a newly developed SDM specifically designed for developing LMSs, or at the very least, that an existing SDM could be adequately adapted to suit the needs of LMS development. The standout SDMs were Object-oriented analysis and Rapid Application Design, which is an agile methodology, which correlates with the literature review done in Chapter 4 and specifically section 4.6 on SDMs for web-based systems. There is, however, a lack of staff experienced in implementing such SDMs.

Technology seems to be the most important critical success factor, when it comes to e-learning systems. It is important to note that the majority of the respondents were involved with the development side of the LMSs. This will perhaps reflect differently when asked from the point of view of an instructor/facilitator or a content designer.

Considering the results obtained from the descriptive analysis, it does seem as though organisations involved in developing e-learning systems are not using systems development methodologies to their full extent when developing LMSs. It supports a theory called Methods-in-Action, that suggests that formalised methodologies are not always being used in the way they are intended to be used (Fitzgerald *et al.*, 2002). Instead, they are adapted on an *ad hoc* basis to suit the requirements of the system being developed.

In the next section, the inferential statistical analyses that were performed will be discussed.

6.3. INFERENCE STATISTICAL ANALYSIS

This section will discuss the inferential statistical analysis that was done in collaboration with Statistical Consultation Services of the Potchefstroom Campus of the North-West University. Section 6.3.1 will reflect the factor analysis that was done on certain questions. In section 6.3.2 the research questions will be evaluated by utilising cross-classification table (crosstab) analysis and nonparametric²⁰ correlations.

6.3.1. ADDITIONAL STATISTICAL TECHNIQUES

Some additional statistical techniques were used for the inferential statistical analysis. These will subsequently be mentioned.

Kaiser-Meyer-Olkin measure of sampling adequacy

The Kaiser-Meyer-Olkin measure of Sampling Adequacy determines the suitability of the dataset for factor analysis. A value closer to 1 indicates that the patterns of correlation are relatively compact and that factor analysis will deliver clear and reliable results. According to Field (2005) it should be at least 0.5. The categories of the KMO measure are as follows:

- Values between 0.5 and 0.7 are average;
- Values between 0.7 and 0.8 are good;
- Values between 0.8 and 0.8 are very good;
- Values above 0.9 are extremely good.

Bartlett's test

Bartlett's test is used to measure the null hypothesis so that the original correlation matrix is an identity matrix. For factor analysis to work, there has to be an affinity between variables, and if it is an identity matrix, then it entails that all correlation coefficients are 0. This test must preferably be significant ($p < 0.001$) (Field, 2005).

Cronbach's alpha

Another statistical measurement that will be used in this section is Cronbach's alpha that measures the reliability of several items in a questionnaire. This is a reliability analysis coefficient that ranges from 0 to 1. A value closer to 1 indicates a higher reliability and as a rule of thumb a Cronbach's alpha of 0.8, or higher, is considered very reliable (Leontitsis & Pagge, 2007).

²⁰ Nonparametric methods are most appropriate when the sample sizes are small, $n < 100$ (StatSoft, 2013).

Effect size

Effect size denoted by (f^2) is a measure that indicates practical significance by using the standardised difference between the means of two populations, i.e. the difference between the two means divided by the estimate for standard deviation. This not only makes the difference independent of units and sample size, but also relates it with the spread of the data (Ellis & Steyn, 2003). Cohen (1988) suggested the following guidelines for effect sizes:

- Values between 0.0 and 0.15 indicate a small effect;
- Values between 0.15 and 0.35 indicate a medium effect;
- Values larger than 0.35 indicate a large effect.

Spearman's rho

Spearman's rank correlation coefficient or Spearman's rho, is a nonparametric measure of statistical dependence between two variables. The closer the value is to 1, the stronger the correlation (StatSoft, 2013). The following categories will be used to describe the strength of the correlation:

- Values between 0.0 and 0.2 indicate a weak relationship;
- Values between 0.2 and 0.4 indicate a moderate relationship;
- Values between 0.4 and 0.6 indicate a strong relationship;
- Values between 0.6 and 1 indicate a very strong relationship.

In the next section, the factor analysis that was performed will be discussed.

6.3.2. FACTOR ANALYSIS

The main purpose of this research study is to determine the supposed influence that SDMs have on LMSs. There are many variables, available from the data, which can be used to answer the stated research questions. Most of the research questions are stated as possible relationships between two entities or constructs. One has to determine the variables that can indicate the existence of such a relationship. Variables that essentially measure the same thing can be grouped into factors. In an effort to identify the abovementioned factors, factor analyses were done on some of the Likert scale questions.

This section will describe how the factor analyses were performed and will make use of the abbreviations given to the constructs as tabulated in Table 5.2 (refer to section 5.2.6). Factor

analysis was performed on the following questions of the questionnaire: questions 9, 10, 16, 17 and 18. Only these questions will therefore be discussed in this section.

6.3.2.1. PERCEIVED SUCCESS OF THE LMS

Question 9 measured the success of the LMS according to the respondents. See Table 6.18 for the variables in the question.

Variable number		Description of variable
Number	Depiction	
9.1	@91	The system is functional
9.2	@92	The system is reliable
9.3	@93	The system is maintainable
9.4	@94	The system is portable
9.5	@95	The system is efficient
9.6	@96	The system is usable
9.7	@97	The developed system meets user needs
9.8	@98	The documentation of the developed system is good
9.9	@99	Overall, the developed system is of high quality
9.10	@910	Overall, the users are satisfied with the developed system
9.11	@911	Overall, the developed system is a success

Table 6.18: Variables in Question 9: Measuring LMS Success

The results of the factor analysis identified one factor and the communalities and total variance explained can be seen in Table 6.19.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.898, which is very good. Bartlett's test produced a p-value of .000, which is significant and indicates that factor analysis is suitable for this data.

- This factor involved variables @91 to @911 and was labelled "Perceived_Success_LMS". It proved to be reliable with a Cronbach's alpha of 0.95. All the variables have been included in this factor.

Variables	Communalities		Total Variance Explained	
	Initial	Extraction	Total	% of Variance
@91	1.000	.715	7.751	70.464
@92	1.000	.698	.784	7.130
@93	1.000	.741	.546	4.961
@94	1.000	.453	.447	4.067
@95	1.000	.730	.375	3.411
@96	1.000	.821	.271	2.465
@97	1.000	.653	.246	2.236
@98	1.000	.634	.215	1.958
@99	1.000	.855	.160	1.452
@910	1.000	.682	.141	1.279
@911	1.000	.770	.064	.578

Table 6.19: Communalities and total variance explained: Question 9

6.3.2.2. SATISFACTION WITH THE LMS PLATFORM

Question 10 measured the satisfaction of the LMS platform according to the respondents. See Table 6.20 for the variables in the question.

Variable number		Description of variable
Number	Depiction	
10.1	@10_1	I'm totally satisfied with our current platform
10.2	@10_2	I would consider using an open-source e-learning system for future projects
10.3	@10_3	I would consider purchasing a proprietary e-learning system for future projects
10.4	@10_4	I would consider the in-house development of an e-learning system for future projects

Table 6.20: Variables in Question 10: Measuring LMS platform satisfaction

The results of the factor analysis indicated that all the variables should be separate factors and the communalities and total variance explained can be seen in Table 6.21. This adheres to logic in that the variables essentially measure different things.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.501, which is average. Bartlett's test produced a p-value of .000, which is significant and indicates that factor analysis is suitable for this data.

- Factor one involved variable @10_1 and was labelled "Satisfaction_with_platform".

- Factor two involved variable @10_2 and was labelled “Willingness_open_source”.
- Factor three involved variable @10_3 and was labelled “Willingness_proprietary”.
- Factor four involved variable @10_4 and was labelled “Willingness_in_house”.

Communalities			Total Variance Explained	
Variables	Initial	Extraction	Total	% of Variance
@10_1	1.000	.648	1.632	40.802
@10_2	1.000	.806	1.273	31.830
@10_3	1.000	.808	.717	17.920
@10_4	1.000	.644	.378	9.447

Table 6.21: Communalities and total variance explained: Question 10

6.3.2.3. PERFORMANCE EXPECTANCY OF AND PERCEIVED SUPPORT OF THE SDM

Question 16 measured the performance expectancy of the SDM and the perceived support that the SDM provides. See Table 6.22 for the variables in the question.

Variable number		Description of variable
Number	Denomination	
16.1	@161	Using an SDM is recommended in my work
16.2	@162	The result of using an SDM is clear to me
16.3	@163	I would be able to communicate to others the consequences of using an SDM
16.4	@164	I would be able to explain why using an SDM may or may not be beneficial
16.5	@165	The application of the SDM is clear to me
16.6	@166	The benefits of using the SDM is apparent
16.7	@167	Overall, I believe the SDM is user-friendly and easy to apply
16.8	@168	The SDM enable me to complete tasks quicker
16.9	@169	The quality of my work is improved by using the SDM
16.10	@1610	It is easier to accomplish my work by using the SDM
16.11	@1611	The effectiveness of my work in systems development was enhanced using an SDM
16.12	@1612	I had greater control over my development work when using an SDM
16.13	@1613	The SDM is compatible with my development work
16.14	@1614	The SDM fits well in the way I like to work
16.15	@1615	I was permitted to use the SDM on a trial basis to see what it can do

Table 6.22: Variables in Question 16: Measuring performance expectancy and support of the SDM

The results of the factor analysis identified two factors. It can clearly be seen in the table of factor loadings, Table 6.23. Loadings below .3 were suppressed. All the variables have been included in these two factors.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.818, which is very good. Bartlett's test produced a p-value of .000, which is significant and indicates that factor analysis is suitable for this data.

- Factor one involved variables @161 to @166 and was labelled "Performance_Expectancy_SDM". It proved to be reliable with a Cronbach's alpha of 0.95.
- Factor two involved variables @167 to @1614 and was labelled "Support_SDM_Provide". It proved to be reliable with a Cronbach's alpha of 0.95.

Variable	Component	
	1	2
@168	.909	
@1612	.896	
@1610	.836	
@1613	.828	
@1611	.757	
@167	.714	
@169	.700	
@1615	.689	
@1614	.677	
@162		-1.022
@164		-.937
@163		-.915
@165		-.861
@166		-.754
@161		-.559

Table 6.23: Factor loading: Question 16

6.3.2.4. PERCEIVED IMPACT OF SDM ON QUALITY AND PRODUCTIVITY

Question 17 measured the perceived impact on quality and productivity of the process of the development process according to respondents. See Table 6.24 for the variables in the question.

Variable number		Description of variable
Number	Denomination	
17.1	@171	The SDM was effective in the design process of the proposed system
17.2	@172	The SDM was effective in implementing the developed system
17.3	@173	The SDM was effective in testing the developed system
17.4	@174	The SDM was effective in reuse of components developed in previous systems
17.5	@175	The SDM helped to get the developed system accepted

Table 6.24: Variables in Question 17: Measuring SDM impact on quality and productivity

The results of the factor analysis identified one factor and the communalities and total variance explained can be seen in Table 6.25.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.604, which is average. Bartlett's test produced a p-value of .000, which is significant and indicates that factor analysis is suitable for this data.

- This factor involved variables @171 to @175 and was labelled "Impact_SDM_Quality_Productivity". It proved to be reliable with a Cronbach's alpha of 0.91. All the variables have been included in this factor.

Variables	Communalities		Total Variance Explained	
	Initial	Extraction	Total	% of Variance
@171	1.000	.776	3.688	73.763
@172	1.000	.705	.664	13.287
@173	1.000	.583	.456	9.125
@174	1.000	.759	.149	2.990
@175	1.000	.866	.042	.836

Table 6.25: Communalities and total variance explained: Question 17

6.3.2.5. PERCEIVED IMPACT OF THE SDM ON THE LMS

Question 18 measured the perceived impact of the SDM on the quality of the product, in this case the LMS. See Table 6.26 for the variables in the question.

Variable number		Description of variable
Number	Denomination	
18.1	@181	The e-learning system is more functional as result of using the SDM
18.2	@182	The e-learning system is more reliable as result of using the SDM
18.3	@183	The e-learning system is more maintainable as result of using the SDM
18.4	@184	The e-learning system is more efficient as result of using the SDM
18.5	@185	The e-learning system is of better quality as result of using the SDM
18.6	@186	The e-learning system is more useable as result of using the SDM
18.7	@187	The users of the e-learning system is more satisfied as result of using the SDM

Table 6.26: Variables in Question 18: Measuring SDM impact on the quality of the LMS

The results of the factor analysis identified one factor and the communalities and total variance explained can be seen in Table 6.27.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.865, which is very good. Bartlett's test produced a p-value of .000, which is significant and indicates that factor analysis is suitable for this data.

- This factor involved variables @181 to @187 and was labelled "Impact_Quality_LMS". It proved to be reliable with a Cronbach's alpha of 0.96. All the variables have been included in this factor.

Variables	Communalities		Total Variance Explained	
	Initial	Extraction	Total	% of Variance
@181	1.000	.849	5.578	79.679
@182	1.000	.902	.597	8.524
@183	1.000	.710	.364	5.196
@184	1.000	.777	.209	2.980
@185	1.000	.867	.115	1.648
@186	1.000	.772	.084	1.200
@187	1.000	.700	.054	.772

Table 6.27: Communalities and total variance explained: Question 18

This section identified variables from the Likert scale questions that can be grouped together into factors. These factors will be used, in conjunction with the other variables, to evaluate the research questions in the next section.

6.3.3. EVALUATION OF THE RESEARCH QUESTIONS

This section will reflect the statistical analyses that were performed in an attempt to answer the research questions. In the conceptual research model (refer to section 5.3.2) paths or relationships that will be assessed, were presented. These assessments will be discussed under the headings of the expanded research question as given in section 5.3.1. This section will make use of the abbreviations given to the constructs as tabulated in Table 5.2 (refer to section 5.2.6).

Research Question (RQ1):

This research question determines if there is a relationship between the industry in which the respondents are utilising their LMS and the platform (open-source or proprietary) on which the LMS is built.

Crosstab analysis (refer to section 2.6) was done on the variables related to these two questions to determine if the type of industry relates to the LMS platform being used.

The variables used in question one of the questionnaire (refer to section 6.2.1.1) are given in Table 6.28 and those of question five are given in Table 6.29.

Variable number		Description of variable
Number	Depiction	
1.1	@1_1	Academic
1.2	@1_2	Private Sector

Table 6.28: Variables in Question 1: Industry

Variable number		Description of variable
Number	Depiction	
5.1	@5_1	Proprietary
5.2	@5_2	Open-source

Table 6.29: Variables in Question 5: LMS platform used

The results of the crosstab analysis can be seen in Table 6.30 and it was statistically significant with $p < 0.001$ and a Cramer's V of 0.709²¹.

²¹ Cramer's V is used to measure the strength of the association between one nominal variable with either another nominal variable, or with an ordinal variable. Both of the variables can have more than 2 categories and should have a value of at least 0.2 (StatSoft, 2013).

In academic institutions open-source LMSs are being used in almost 61% of the cases and in the private sector just above 52%. From the commentary received from many of the respondents and candidate respondents from the academic institutions that were contacted, it was expected that the use of open-source LMSs would be higher. One could perhaps construe this result in perspective. Many of the academic institutions indicated that they are in the process of moving towards an open-source learning management system but that they are currently still using a proprietary LMS.

Industry	LMS Platform		Total
	Proprietary	Open-source	
Academic	39.3%	60.7%	100.0%
Private Sector	47.4%	52.6%	100.0%
Total	42.6%	57.4%	100.0%

Table 6.30: Crosstab analysis: Research Question 1

Research Question (RQ2):

This research question determines if there is a relationship between the industry in which the respondents are utilising their LMS and the number of students, learners or employees being trained by using this LMS.

Crosstab analysis was done on the variables related to these two questions to determine if the type of industry relates to the number of users of the specific LMS in question.

The variables used in question one of the questionnaire, are given in Table 6.28 and those of question four are given in Table 6.31.

Variable number		Description of variable
Number	Depiction	
4.1	@4_1	1-99
4.2	@4_2	100-499
4.3	@4_3	500-999
4.4	@4_4	1000-4999
4.5	@4_5	5000- 9999
4.6	@4_5	10 000 or more

Table 6.31: Variables in Question 4: Number of users

The results of the crosstab analysis can be seen in Table 6.32. It was statistically significant with $p < 0.01$ and a Cramer's V of 0.568.

Some of the results will subsequently be highlighted:

- It is quite noticeable that 75% of the academic institutions' LMSs are being utilised for 10 000 or more students, learners or employees.
- The private sector almost exclusively uses LMSs with more than a 1 000 users.

Industry	Number of students/learners/employees using the LMS						
	1-99	100-499	500-999	1000-4999	5000 - 9999	10 000 or more	Total
Academic	7.1%	10.7%	0%	0%	7.1%	75%	100.0%
Private Sector	0%	15.8%	0%	21.1%	31.6%	31.6%	100.0%
Total	4.3%	12.8%	0%	8.5%	17%	57.4%	100.0%

Table 6.32: Crosstab analysis: Research Question 2

Research Question (RQ3):

This research question determines if there is a relationship between the industry in which the respondents are utilising their LMS and the method of procurement of the LMS.

Crosstab analysis was done on the variables related to these two questions to determine if the type of industry relates to the LMS platform being used.

The variables used in question one of the questionnaire, are given in Table 6.28 and those of question five are given in Table 6.33.

Variable number		Description of variable
Number	Depiction	
6.1	@6_1	Purchased
6.2	@6_2	Developed in-house
6.3	@6_3	Outsourced
6.4	@6_4	Open-source (used as-is)
6.5	@6_5	Adapted from open-source system

Table 6.33: Variables in Question 5: Method of procurement of LMS

The results of the crosstab analysis can be seen in Table 6.34 and it was statistically significant with $p < 0.05$ and a Cramer's V of 0.447.

Some of the results will subsequently be highlighted:

- There is very little in-house development being done when it comes to the procurement of LMSs with a combined (academic and private sector) total of 17.4% of the respondents indicating that they make use of in-house development.
- With 32.6% of the procurement of LMSs being done by adapting open-source LMSs, it is by far the preferred method of procuring an LMS.
- To elaborate on the abovementioned adaption of open-source LMS, it is worth noting that 39.3% of academic institutions use open-source systems "as is", while only 5.6% of the private sector use LMSs "as is".
- Only 21.4% of academic institutions adapt their LMSs compared to the 50% of the private sector.
- A combined total of 23.9% of the procurement of LMSs are being done by purchasing off the shelf products.

Industry	Procurement of LMSs				Total
	Purchased	In-house	Open-source (used as-is)	Adapted from open-source system	
Academic	25%	14.3%	39.3%	21.4%	100.0%
Private Sector	22.2%	22.2%	5.6%	50%	100.0%
Total	23.9%	17.4%	26.1%	32.6%	100.0%

Table 6.34: Crosstab analysis: Research Question 3

Research Question (RQ4):

This research question determines if there is a relationship between the platform of the LMS used and the perceived success of the LMS.

T-tests indicated that the LMS platform had a medium effect on the success of the LMS with an effect size (f^2) of 0.34 and a statistical significance, $p > 0.05$.

Research Question (RQ5):

This research question determines if there is a relationship between the platform of the LMS used and the satisfaction of the platform.

T-tests indicated that the platform of the LMS has a very high effect on the inclination of respondents to consider using an **open-source** LMS for future projects with an effect size (f^2) of 1.71²² and it is statistically significant with $p < 0.001$.

- Respondents that use an open-source LMS would be inclined to keep using an open-source LMS for future projects with a mean value of 4.4.²³
- Respondents that use a proprietary LMS will be less inclined to consider an open-source LMS for future projects with a mean value of 2.75.

T-tests also indicated that the platform of the LMS has a very high effect on the inclination of respondents to consider using a **proprietary** LMS for future projects with an effect size (f^2) of 1.04 and it is statistically significant with $p < 0.001$.

- Respondents that use a proprietary LMS would be inclined to keep using a proprietary LMS for future projects with a mean value of 3.65.
- Respondents that use an open-source LMS will be less inclined to consider a proprietary LMS for future projects with a mean value of 2.4.

Research Question (RQ6):

This research question determines if there is a relationship between the procurement method of the LMS and the satisfaction of the platform used.

T-tests indicated that the procurement method of the LMS has a very high effect on the inclination of respondents to consider using an **open-source** LMS for future projects.

- Respondents that use an open-source LMS would be inclined to consider using open-source LMS (as is, i.e. not adapting it) for future projects with an effect size (f^2) of 2.11 and it is statistically significant with $p < 0.001$.
- Respondents that use an open-source LMS would be inclined to consider using open-source LMS (as is, i.e. not adapting it) for future projects with an effect size (f^2) of 2.16 and it is statistically significant with $p < 0.001$.

²² Effect sizes can be larger than 1 (Ellis & Steyn, 2003).

²³ All the means are indicated as a value out of a possible 5, as a five-point Likert scale was used.

- Respondents that use an open-source LMS would also be inclined to consider adapting an open-source LMS for future projects with an effect size (f^2) of 1.50 and it is statistically significant with $p < 0.001$.
- Respondents that use a proprietary LMS would also be inclined to consider adapting an open-source LMS for future projects with an effect size (f^2) of 1.45 and it is statistically significant with $p < 0.001$.

It is clear that the respondents will consider using open-source LMSs for future projects, but they are less inclined to adapt such LMSs, than using them as is.

Research Question (RQ7):

This research question determines if there is a relationship between the perceived success of the LMS and the satisfaction of the platform used.

There is strong relationship that exists between the success of the LMS and the satisfaction of the platform used with a Spearman's rho of 0.589 and it is statistically significant with $p < 0.001$.

Research Question (RQ8):

This research question determines if formal SDMs are being used in the development of LMSs. This question was answered in the descriptive statistical analysis section (specifically sub-section 6.2.3.1).

To reiterate, 79.41% (refer to Table 6.8) of the respondents indicated that they use a *formal* SDM in developing LMSs or tools for LMSs.

Research Question (RQ9):

This research question determines which formal SDMs are being used in the development of LMSs. This question was answered in the descriptive statistical analysis section (specifically sub-section 6.2.3.3)

To reiterate, Object-Oriented Analysis (OOA) is the SDM that is used to the most, with only 14.71% (refer to Table 6.10) of the respondents indicating that they do not use OOA at all. Rapid Application Development (RAD) is the second most used SDM with 65% (refer to Table 6.10) of the respondents indicating as much.

Research Question (RQ10):

This research question determines if there is a relationship between the type of formal standard SDM used and the success of the LMS.

T-tests indicated that the use of formal SDMs had a medium effect on the success of the LMS with an effect size (f^2) of 0.34 and a statistical significance, $p < 0.05$.

Research Question (RQ11):

This research question determines if there is a relationship between the type of formal standard SDM used and the impact of the SDM on the quality and productivity of the development process. The SDMs that were given as options can be seen in Table 6.10. The results of the statistical analysis that was done for this research question will subsequently be highlighted:

- There is a moderate relationship that exists between respondents that indicated that they use OOA as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.281. $p > 0.05$.
- There is strong relationship that exists between respondents that indicated that they use RUP as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.382. $p < 0.05$.
- There is medium relationship that exists between respondents that indicated that they use XP as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.246. $p > 0.05$.
- There is very strong relationship that exists between respondents that indicated that they use RAD as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.618. $p < 0.001$.
- There is strong relationship that exists between respondents that indicated that they use IE as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.517. $p < 0.01$.
- There is strong relationship that exists between respondents that indicated that they use SSM as SDM and the impact this SDM had on the quality and productivity of the development process. Spearman's rho = 0.441. $p < 0.01$.

The SDM with the strongest influence on the quality and productivity of the development process is RAD, which is an Agile methodology. Even though OOA is used the most (refer to Table 6.10), according to the respondents, it does not have a very strong influence on the quality and productivity of the development process.

Research Question (RQ12):

This research question determines if there is a relationship between the performance expectancy of the SDM and the impact of the SDM on the quality and productivity of the development process.

There is a strong relationship that exists between the performance expectancy of the SDM and the impact of the SDM on the quality and productivity of the development process with a Spearman's rho of 0.563 and it is statistically significant with $p < 0.01$.

Research Question (RQ13):

This research question determines if there is a relationship between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS.

There is a strong relationship that exists between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS with a Spearman's rho of 0.547 and it is statistically significant with $p < 0.01$.

Research Question (RQ14):

This research question determines if there is a relationship between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process.

There is a very strong relationship that exists between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process with a Spearman's rho of 0.744 and it is statistically significant with $p < 0.001$.

Research Question (RQ15):

This research question determines if there is a relationship between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS.

There is a strong relationship that exists between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS with a Spearman's rho of 0.541 and it is statistically significant with $p < 0.01$.

Research Question (RQ16):

This research question determines if there is a relationship between the impact of the SDM on the quality and productivity of the development process and the success of the LMS.

There is a weak relationship that exists between the impact of the SDM on the quality and productivity of the development process and the success of the LMS with a Spearman's rho of 0.177 and it is not statistically significant with $p > 0.05$.

One has to keep in mind that the first factor used in this research question is the impact of the SDM on the quality and productivity of the development process (Impact_SDM_Quality_Productivity, refer to section 6.3.1.4) and this factor has a more direct influence on the development process and not on the end product or LMS.

Research Question (RQ17):

This research question determines if there is a relationship between the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS.

There is a strong relationship that exists between the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS with a Spearman's rho of 0.543 and it is statistically significant with $p < 0.01$.

Research Question (RQ18):

This research question determines if there is a relationship between the perceived impact of the SDM on the quality of the LMS and the success of the LMS.

There is a moderate relationship that exists between the perceived impact of the SDM on the quality of the LMS and the success of the LMS with a Spearman's rho of 0.376 and it is statistically significant with $p < 0.05$.

Research Question (RQ19):

This research question determines if there is a need to design an SDM specific to LMS development and the success (or lack thereof) of the current LMS used.

There is a moderate relationship between the need to design an SDM specific to LMS development and the success of the current LMS used with a Spearman's rho of 0.322 and a statistical significance (p) of 0.063.

Research Question (RQ20):

This research question determines if there is a need to design an SDM specific to LMS and the SDM that was used to design the current LMS.

- There is a strong negative relationship that exists between respondents that indicated that they use another (not listed) SDM and on opinion that there is room for a newly designed SDM specifically for developing LMSs with a Spearman's rho = -0.402 and a statistical significance, $p < 0.05$.
- There is a strong relationship that exists between respondents that indicated that they use another (not listed) SDM and on the opinion that an existing SDM can be adequately adapted to suit the needs of e-learning with a Spearman's rho = 0.437 and a statistical significance, $p < 0.01$.
- There is a strong negative relationship that exists between respondents that indicated that they use SSM as an SDM and on the opinion that an existing SDM can be adequately adapted to suit the needs of e-learning with a Spearman's rho = -0.513 and a statistical significance, $p < 0.01$.
- There is a moderate negative relationship that exists between the respondent that indicated that they use IE (Information Engineering) as SDM and the opinion that an existing SDM can be adequately adapted to suit the needs of e-learning with a Spearman's rho = -0.399 and a statistical significance, $p < 0.05$.

A summary of the results of the statistical analyses that were performed, and the relationships that were evaluated, can be seen in Table 6.35. An updated conceptual research model, that indicates the research questions that were evaluated, can be seen in Figure 6.5.

This concludes the evaluation of the research questions. The next section will summarise this chapter and discuss the results of the inferential statistical analysis.

Research Question	Path tested	Spearman's rho (ρ) / Cramer's V (φ)	Effect Size (f^2)	Relationship / Correlation / Level of Association
RQ1	Industry → Platform_Used	$\varphi_c = 0.709^{***}$	n/a	Very strong
RQ2	Industry → Number_Users	$\varphi_c = 0.568^{**}$	n/a	Very strong
RQ3	Industry → Procurement_LMS	$\varphi_c = 0.447^*$	n/a	Very strong
RQ4	Platform_Used → Success LMS	n/a	0.34	Small effect
RQ5	Platform_Used → Satisfaction_LMS_Platform	n/a	1.71*** 1.04***	Very high effect
RQ6	Procurement_LMS → Satisfaction_LMS_Platform	n/a	2.11*** 2.16*** 1.50*** 1.45***	Very high effect
RQ7	Success LMS → Satisfaction_LMS_Platform	$\rho = 0.589^{***}$	n/a	Strong
RQ8	Formal SDM Use	n/a See 6.2.3.1	n/a	n/a
RQ9	Extent_Standard_SDM	n/a See 6.2.3.3	n/a	n/a
RQ10	Formal_SDM_Use → Success_LMS	n/a	0.34*	Moderate
RQ11	Extent_Standard_SDM (RAD) → Impact_SDM_Quality_Productivity	$\rho = 0.618^{***}$	n/a	Very strong
RQ12	Performance Expectancy SDM → Impact_SDM_Quality_Productivity	$\rho = 0.563^{**}$	n/a	Strong
RQ13	Performance Expectancy SDM → Impact_Quality_LMS	$\rho = 0.547^{**}$	n/a	Strong
RQ14	Perceived Support SDM → Impact_SDM_Quality_Productivity	$\rho = 0.744^{***}$	n/a	Very strong
RQ15	Perceived Support SDM → Impact_Quality_LMS	$\rho = 0.541^{**}$	n/a	Very strong
RQ16	Impact_SDM_Quality_Productivity → Success LMS	$\rho = 0.177'$	n/a	Weak

RQ17	Impact_SDM_Quality_Productivity → Impact_Quality_LMS	$\rho = 0.543^{**}$	n/a	Strong
RQ18	Impact_Quality_LMS → Success LMS	$\rho = 0.376^*$	n/a	Moderate
RQ19	Need_SDM_LMS → Success_LMS	$\rho = 0.322$	n/a	Moderate (not significant)
RQ20	Need_SDM_LMS → Extent_Standard_SDM (Other)	$\rho = 0.437^{**}$	n/a	Strong

Table 6.35: Research questions as tested (Note: p = Level of Significance. *= <0.001, **= <0.01, *= <0.05, '=<0.1; n/a=this type of test could not/was not performed)**

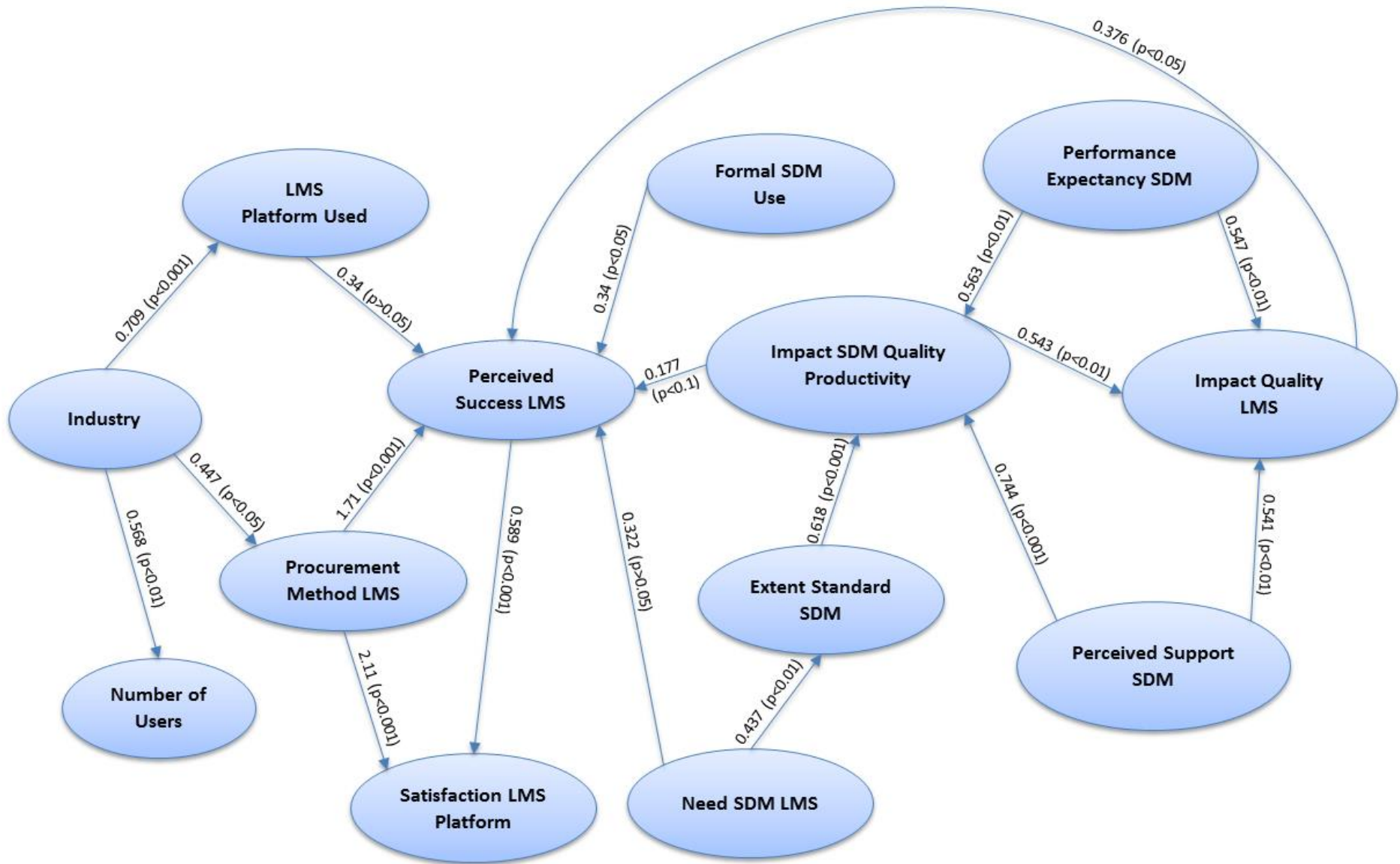


Figure 6.5: Conceptual research model - research questions evaluated

6.3.4. DISCUSSION AND FINAL COMMENTS ON INFERENTIAL STATISTICS

The inferential statistics that are presented in this section reveal some interesting facts about the relationships between certain constructs related to learning management systems and systems development methodologies in South Africa. The most important findings will consequently be highlighted.

Before the evaluation of the research questions could be done, the factors that could indicate such a relationship had to be identified. This was done on some of the Likert scale questions (refer to section 6.3.2).

In section 6.3.3 the evaluation of the research questions was done and this valuation provides answers to all these questions stated originally in section 1.3, and which were later on expanded in section 5.3.1.

Crosstab analysis indicated that open-source learning management systems are preferred to proprietary LMSs, especially in the academic sector. It also revealed that the majority of LMSs in South Africa are being used for 10 000 or more users. Academic institutions also tend to use open-source LMSs as is and the private sector adapts open-source LMSs to a large extent.

There is strong relationship that exists between the perceived success of the LMS and the satisfaction of the platform used. It makes sense that respondents will be satisfied with their LMS platform if the LMS is successful. In general, respondents are very satisfied with their current LMS platform. Open-source LMS users are not inclined to consider a proprietary LMS for future projects. Proprietary LMS users may be inclined to consider an open-source LMS for future projects. Both proprietary and open-source LMS users will be less inclined to adapt an open-source LMS, than using it as is.

There is a very strong relationship that exists between respondents that indicated that they use RAD as SDM and the impact this SDM had on the quality and productivity of the development process. This correlates with what the literature revealed on the use of Agile methodologies in the post-methodology era (refer to section 4.6.2). Although Object-Oriented Analysis is still being used to a large extent, it appears that developers that use OOA do not feel that it has a strong impact on the quality and productivity of the development process.

There is also a strong relationship that exists between the performance that users expect SDMs can provide and the impact that the specific SDMs have on the quality and productivity of the development process. A very strong relationship exists between the support that the SDM provides in the development process and the actual impact that the SDM has on the quality and productivity of the development process.

Both the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process have a strong influence on the impact the SDM has on the quality of the LMS.

In the next chapter, the study will be concluded and final comments will be made.

CHAPTER 7

CONCLUSION AND FINAL COMMENTS

7.1. INTRODUCTION

This chapter will culminate the study by giving an overview of the complete study. Firstly, the purpose of the study will be reviewed (section 7.2). This will be followed by a discussion of the research contributions (section 7.3) that will be done by highlighting the findings and results of the study and answering the research questions. Section 7.4 will confer the limitations of this research study and will suggest possible future research that may be able to contribute to this field of study. The practical implications of the research will be reflected on in section 7.5. This chapter will be summarised and the study concluded in section 7.6.

7.2. REVIEW OF THE PURPOSE OF THE STUDY

The aim of this study was to research the use and effectiveness of SDMs in the development of e-learning systems. The objectives were stated in the form of the following research questions:

- i. Are SDMs currently being used in developing e-learning systems?
- ii. If so, which SDMs are being used?
- iii. Are the SDMs being used effectively?
- iv. Is there a difference between the SDMs used for proprietary and open-source systems?
- v. How can a specific SDM be adapted to better suit e-learning systems?
- vi. Can an SDM be developed to promote the chances of success for developing e-learning systems?

The research questions were expanded (in section 5.3.1), whilst still adhering to the original research questions. The next section will answer the research questions.

7.3. SUMMARY OF THE RESULTS

Relevant and reliable empirical data were collected with the measurement element. The results obtained from this research study, in relation to the research questions stated (refer to sections 1.3 and 5.3.1) will consequently be summarised. In section 7.3.1 the outcomes of

the descriptive statistical analysis that were attained, will be highlighted, and in section 7.3.2 those of the inferential statistical analysis. The original research objectives will be addressed in section 7.3.3.

7.3.1. RESULTS OF THE DESCRIPTIVE STATISTICAL ANALYSIS

In Chapter 6 (refer to section 6.2), the results of the descriptive statistical analysis that was carried out, were discussed in depth. This section will highlight some of those findings.

Both academic institutions and the private sector were approached to participate in this study. A higher response rate was obtained from the academic institutions. The respondents that returned the questionnaire were mostly developers, project leaders and people involved in the deployment of LMSs or involved with user support. More than half of the respondents indicated that their LMSs are being used for 10 000 or more learners.

More than half of the respondents use an open-source LMS and almost a third of all the respondents adapt their open-source LMS to suit their needs. Overall, the respondents perceived their LMS to be successful with almost half of them indicating that they agreed completely that their LMSs are efficient. A great number of respondents answered in the affirmative that they would consider an open-source LMS for future projects. Technology stood out as the most important critical success factor of e-learning for this population of developers, project leaders, etc.

Almost 80% of the respondents, that answered the section of the questionnaire on systems development methodologies, indicated that they made use of formal SDMs. This is in line with recent studies done in South Africa. It appears that development teams involved with LMS projects are relatively small with more than half of the respondents indicating project teams of five members or less. Many of the standard SDMs are not being used to their full extent but the two standout SDMs were Object-Oriented Analysis and Rapid Application Development, which is an agile methodology. Almost none of the respondents use an SDM rigorously and more than half adapt them based on the specific needs of the project. This is in line with what is known about the contingent use of SDMs (refer to section 4.2).

More than three quarters of the respondents were positive on the support and benefits that SDMs provide and almost as many answered in the affirmative that SDMs could have a positive impact on the development process. Many of the respondents were positive that SDMs could be advantageous in the development of LMSs in terms of the reliability, maintainability, efficiency and the quality of the LMS. Almost three quarters of the

respondents indicated that they would adapt SDMs for future projects as needed for the specific project. Respondents indicated a substantial lack of personnel experienced in the use of SDMs as the major reason for the non-use of SDMs in development projects. They agreed on statements regarding the benefits SDMs have to offer as well as SDMs being recommended in their development work.

More than half of the respondents did not see LMSs as a special kind of information system but rather as a regular web-based application (refer to section 4.6). However, almost three quarters of the respondents felt that there may be room for a newly designed SDM that could enhance their LMS development work.

This concludes the summary of the findings in respect of the descriptive statistical analysis.

7.3.2. RESULTS OF THE INFERENCE STATISTICAL ANALYSIS

In Chapter 6 (refer to section 6.3) of this study, the results of the inferential statistical analysis that was carried out, were discussed in depth. This section will highlight some of those findings.

Factor analysis was done on the Likert scale questions of the questionnaire to ascertain which variables could be grouped together, to ultimately determine the existence of possible relationships between the identified constructs. In section 6.3.3 the expanded list of research questions (refer to section 5.3.1) were evaluated. These results will subsequently be listed.

1. *Is there a relationship between the industry in which the LMS is being utilised and the platform (open-source or proprietary) on which the LMS is built?*
 - Academic institutions are clearly using open-source LMSs more than proprietary LMSs. The private sector also uses open-source LMSs more than proprietary LMSs, but only just.

2. *Is there a relationship between the industry in which the LMS is being utilised and the number of users of the LMS in question?*
 - Academic institutions almost exclusively utilise LMSs for 10 000 or more students or learners. The private sector utilises LMSs for any number of learners, but the greatest spread is for more than a 1 000 users.

3. *Is there a relationship between the industry in which the LMS is being utilised and the method of procurement of the LMS?*
 - Academic institutions mostly use open-source LMSs as is, that is to say without any modifications. More than half of the private sectors' LMS procurement is being done by adapting open-source LMSs.
4. *Is there a relationship between the platform of the LMS used and the perceived success of the LMS?*
 - The LMS platform had a moderate effect on the success of the LMS.
5. *Is there a relationship between the platform of the LMS used and the satisfaction of the platform?*
 - The platform of the LMS used had a very high effect on the *satisfaction* of the platform.
 - Open-source LMS users were very satisfied with their LMS platform and not inclined to consider a proprietary LMS for future projects. Proprietary LMS users may be inclined to consider an open-source LMS for future projects.
6. *Is there a relationship between the procurement method of the LMS and the satisfaction of the platform used?*
 - The procurement method of the LMS had a very high effect on the satisfaction of the platform.
 - Both proprietary and open-source LMS users would be less inclined to adapt open-source LMSs, than using them as is.
7. *Is there a relationship between the perceived success of the LMS and the satisfaction of the platform used?*
 - There was a strong relationship between the perceived success of the LMS and the satisfaction of the platform used.
8. *Are formal SDMs being used in the development of LMSs?*
 - For the population of this study, 79% of the respondents indicated that they used formal SDMs in the development of LMSs.

9. *If so, which formal SDMs are being used in the development of LMSs?*
- Respondents indicated that Object-Oriented-Analysis and Rapid Application Development were mostly used in the development of LMSs.
10. *Is there a relationship between the type of formal standard SDM used and the perceived success of the LMS?*
- The use of formal SDMs had a medium effect on the success of the LMS.
11. *Is there a relationship between the type of formal standard SDM used and the impact of the SDM on the quality and productivity of the development process?*
- It was found that a moderate relationship exists between respondents that indicated that they use OOA as SDM and the impact this SDM had on the quality and productivity of the development process.
 - It was found that a **very strong relationship** exists between respondents that indicated that they use RAD as SDM and the impact this SDM had on the quality and productivity of the development process.
12. *Is there a relationship between the performance expectancy of the SDM and the impact of the SDM on the quality and productivity of the development process?*
- It was found that a strong relationship exists between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS.
13. *Is there a relationship between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS?*
- It was found that a strong relationship exists between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS.
14. *Is there a relationship between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process?*

- It was found that a **very strong relationship** exists between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process.

15. Is there a relationship between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS?

- It was found that a strong relationship exists between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS.

16. Is there a relationship between the impact of the SDM on the quality and productivity of the development process and the perceived success of the LMS?

- It was found that a weak relationship exists between the impact of the SDM on the quality and productivity of the development process and the success of the LMS.

17. Is there a relationship between the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS?

- It was found that a strong relationship exists between the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS.

18. Is there a relationship between the perceived impact of the SDM on the quality of the LMS and the perceived success of the LMS?

- It was found that a moderate relationship exists between the perceived impact of the SDM on the quality of the LMS and the success of the LMS.

19. Is there a relationship between the need to design an SDM specific to LMS development and the perceived success (or lack thereof) of the current LMS used?

- It was found that a moderate relationship exists between the need to design an SDM specific to LMS development and the success of the current LMS.

20. Is there a relationship between the need to design an SDM specific to LMS development and the SDM that was used to design the current LMS?

- Not many relationships were found between the specific SDM respondents used and their need for a newly designed LMS-specific SDM. The only notable positive relationship that was found was the one that exists between the respondents that indicated that they used another (not listed) SDM and their opinion that an existing SDM could be adequately adapted to suit the needs of e-learning.

The statistical significant results of the evaluated research questions can be seen in Figure 7.1.

This concludes the summary of the findings in respect of the inferential statistical analysis.

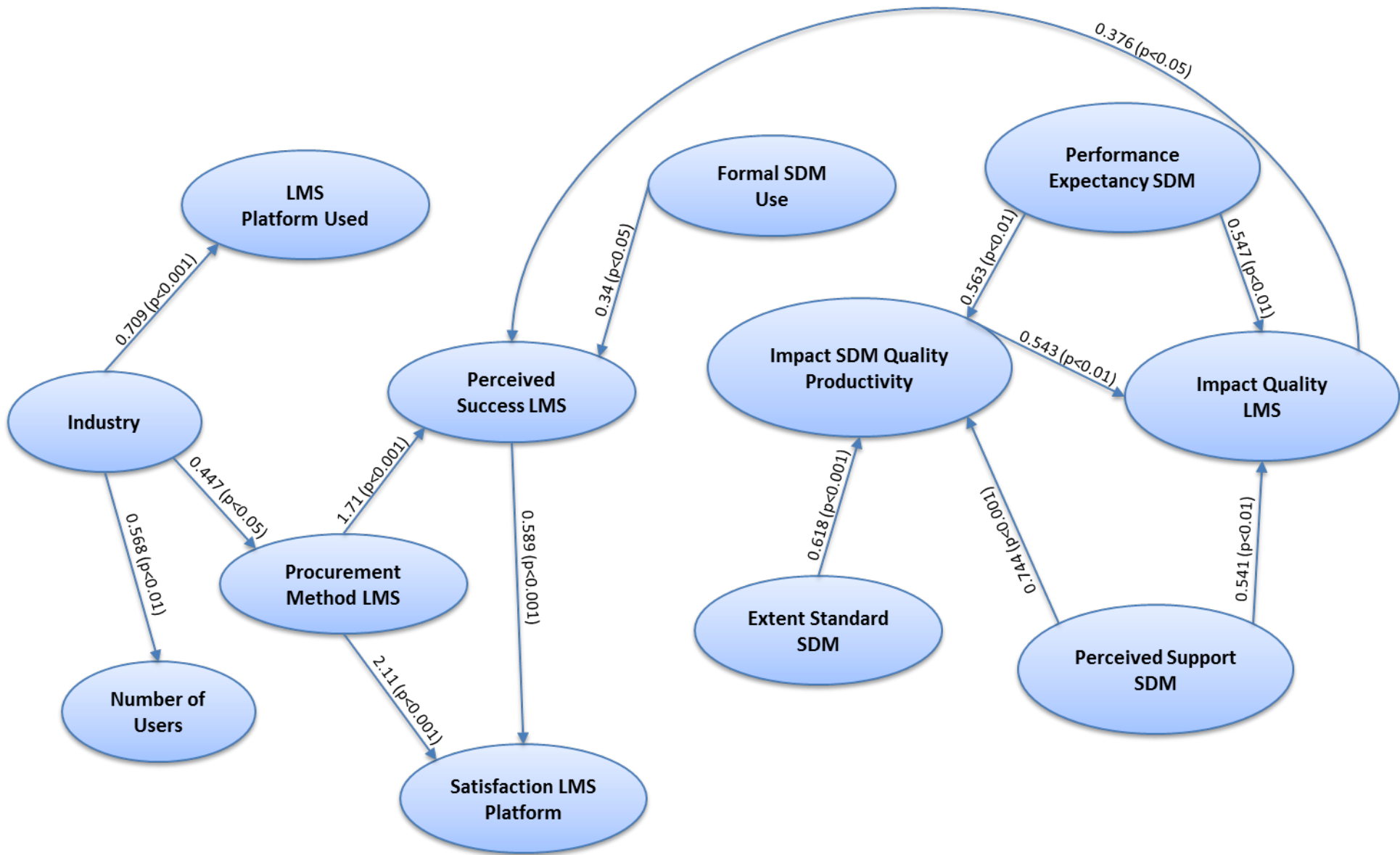


Figure 7.1: Conceptual research model - significant results

7.3.3. ADDRESSING THE ORIGINAL RESEARCH OBJECTIVES

Although the research questions were expanded (refer to section 5.3.1) to address the objectives in greater detail, in this section the original research objectives will be discussed as well.

The main objectives (refer to section 1.3) will subsequently be discussed.

- i. Are SDMs currently being used in developing e-learning systems?*
 - SDMs are being used in more than 79% of the cases.

- ii. If so, which SDMs are being used?*
 - Respondents indicated that Object-Oriented Analysis and Rapid Application Development are mostly used.

- iii. Are the SDMs being used effectively?*

From the statistical analyses reflected in Chapter 6, one can infer that the utilisation of SDMs in the development of LMSs is effective. This statement will subsequently be discussed.

A very high number of the respondents were extremely positive on statements regarding the success of their LMSs. From this, together with the fact that almost 80% of the respondents indicated that SDMs are being used in the development of LMSs, one can deduce that SDMs are being used effectively. Some confirming factors include that a great number of the respondents are positive regarding the perceivable results SDMs have on their projects and also on the benefits SDMs have to offer. Respondents also indicated that they had greater control over their development work and that SDMs were effective with regard to the development process. LMSs are more reliable and maintainable as result of using SDMs.

A strong relationship was found between the perceived support that the SDM provide and the perceived impact of the SDM on the quality of the LMS. This was also found with the impact of the SDM on the quality and productivity of the development process and the perceived impact of the SDM on the quality of the LMS.

Although OOA stood out as the SDM that was used the most, RAD was indicated as the SDM that had the biggest impact on the quality and productivity of the development process.

iv. *Is there a difference between the SDMs used for proprietary and open-source systems?*

There is a difference between the SDMs utilised by respondents that indicated that they use a proprietary LMS and those that use an open-source LMS.

- Of the 85% of the respondents that indicated that they utilised OOA to some extent, 32% of them did so for a proprietary LMS and 53% for an open-source LMS.
- Of the 65% of the respondents that indicated that they utilised RAD to some extent, 30% of them did so for a proprietary LMS and 35% for an open-source LMS.

v. *How can a specific SDM be adapted to better suit e-learning systems?*

From the literature review done in Chapter 4, one can argue that an adapted SDM will be based on agile methodologies, more specifically RAD. It will factor in the e-learning content aspect and adhere to instructional design models, specifically the ADDIE model. This statement will subsequently be discussed.

A high number of the respondents indicated that they would adapt SDMs for future projects to suit the needs of the specific project. The literature showed that the post-methodology era is categorised by the adaption of SDMs on a project-to-project basis. This is in line with the contingent use of SDMs where organisations are choosing a “best fit” SDM to suit the needs of their current and future development projects.

The SDM that had the greatest impact on the quality and productivity of the development process was RAD, which is an agile methodology. The literature revealed that many of the so-called e-learning methodologies are instructional systems design models rather than actual software development methodologies. Instructional systems design models focus on delivering content for e-learning systems, rather than developing the actual LMS itself. An LMS-specific SDM will have to incorporate an ISD model.

vi. *Can an SDM be developed to promote the chances of success for developing e-learning systems?*

From the literature review done in Chapter 4, one can argue that a newly designed SDM will be based on agile methodologies, more specifically RAD. It will factor in the e-learning content aspect and adhere to instructional design models, specifically the ADDIE model. This statement will subsequently be discussed.

A high number of the respondents agreed that there was room for a newly designed SDM for developing LMSs. The respondents were mostly neutral on the uniqueness of LMSs in terms of them being a special type of information system

The literature revealed that SDMs for web-based systems have the most in common with the attributes and requirements of e-learning systems. Agile methodologies, more specifically RAD, were indicated as having the greatest impact on the quality and productivity of the development process. Hardly any SDMs could be found that are being used specifically for the development of LMSs. However, a couple of academic endeavours have been made to propose possible SDMs for developing LMSs. No evidence of the implementation of such SDMs was found.

The literature also revealed that many of the so-called e-learning methodologies are instructional systems design models rather than actual software development methodologies. Instructional systems design models focus on delivering content for e-learning systems, rather than developing the actual LMS itself. An LMS-specific SDM will have to incorporate an ISD model.

This concludes the discussion on the findings regarding the original research questions.

7.4. LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

While this study's major objectives were accomplished, it has some limitations which should be viewed as opportunities for future research.

From the moment the researchers first started distributing the questionnaires, it became apparent that this is a very niche market in South Africa. It was considered to expand the research population to overseas countries. This would have almost certainly increased the

number of responses received from the questionnaires. However, the specific brief for this study was to look at how learning management systems are being developed in South Africa. This limited the number of respondents to 50, which in itself was no mean feat, considering the very small number of universities and private sector developers there are. The small number of possible respondents also made random sampling²⁴ impossible. The researchers did not “target” any one institution or organisation for response to the questionnaire; nonetheless, simple random sampling applied to a larger population would have been ideal. Thus, this study only focussed on learning management systems in South Africa. Conducting this kind of research in other countries could be very informative.

By using an email-based survey and by arduously searching the Internet for companies in the business of learning management systems, the researchers compiled a list of possible respondents. Many organisations do not list the email addresses of the developers or project team, only *general queries* or *information* email addresses. Many organisations did not respond to the emails that were sent out. If one had a more comprehensive list of system developers in this field of information systems development, the number of responses could be higher.

Surveys, more specifically questionnaires, were used as research strategy for this study. Questionnaires can be limiting in the sense that it is a “passive” method of data generation. The researcher cannot interrupt the process and delve deeper into a certain aspect or question. Structured and unstructured interviews could be considered to overcome this limitation. Future research could also make use of other measurement elements, in combination with surveys, to gather more in-depth knowledge on a subject.

Almost 75% of the respondents indicated that there may be room for a newly designed SDM specifically for the development of LMSs and tools for LMSs. This could well be a great opportunity for future research in this field.

This study may serve as a stimulus for future research in the field of learning management systems and more specifically the development of LMSs by using systems development methodologies to enhance the chances of success for those systems.

²⁴ Simple random sampling chooses a subset of a larger population with each element having the same chance of being selected, which minimises population selection bias (Emory & Cooper, 1991).

7.5. CONTRIBUTIONS AND PRACTICAL IMPLICATIONS OF THE STUDY

This study had various practical implications and these will be discussed in this section.

Firstly, the study made a contribution to the discipline of information systems, and more specifically, learning management systems, by providing insights with regard to the factors effecting the use and effectiveness of SDMs in developing LMSs. It also contributes to the acceptable body of knowledge on abovementioned fields of study.

As far as could be ascertained, empirical research on the use of systems development in developing learning management systems in South Africa, does not exist. This study gave some insights into how LMS procurement and development is being done, which in itself is a noteworthy contribution.

As far as could be ascertained, this study generated the first empirical data on the procurement and development of LMSs in South Africa. A holistic picture was drawn on what the South African e-learning market looks like and it was determined that the extent of use of open-source LMSs exceeds what was initially believed. Many of the unknowns surrounding e-learning and learning managements systems were clarified.

Numerous relationships were identified between the various factors influencing the use and effectiveness of SDMs, such as the impact SDMs have on the quality of the development process, and the actual quality or the success of the LMS.

It was substantiated that SDMs are being used in the development of LMSs and that they are effective to a large degree.

The study also unlocks various future research possibilities in the emerging field of LMS development.

7.6. CONCLUSION TO THE STUDY

This study attempted to provide some insights into the use and effectiveness of systems development in developing learning management systems and the supposed influence SDMs can have on the quality of LMSs. This was done by considering relevant constructs and measurements and the relationships between them. From the literature it was established that little research exists in these two related fields of study.

A research plan was constructed and the steps needed to conduct the research study were identified.

The first step in the research plan was to conduct a literature review on research methods. This step gave a good working knowledge on how to go about a research problem and it was determined that this study would be done in the positivistic research paradigm. Quantitative data was to be generated by using the *survey* research strategy, more specifically questionnaires. Questionnaires are the preferred data generation method for research in the field of information systems.

The next step was to conduct a literature review on e-learning systems, or learning management systems as it is commonly known, as well as systems development methodologies. This step gave one a firm grasp on the collective knowledge of these to interrelating fields of research.

After the literature review was concluded, constructs were identified and the research questions conceptualised. These constructs were combined into a measurement instrument and operationalised into a well-designed questionnaire. Another deliverable of this step was the conceptual research model that indicated which relationships (between the constructs) were to be investigated. This model conceptualised the research problem and specified how the expanded research questions would be addressed.

The final step was to apply statistical analyses to the dataset gathered. These analyses were in the form of a descriptive statistical analysis and an interpretive statistical analysis.

As conclusion the results were interpreted, the limitations and recommendations on future research were discussed and the contributions and practical implications were discoursed.

This study gave some insights into how LMS procurement and development is being done in South Africa and revealed that the use of open-source LMSs currently exceeds the use of proprietary LMSs.

The results of the research showed that systems development methodologies are being used effectively in the development of e-learning systems. Strong relationships exists between many of the SDM factors identified and the quality and productivity of the

development process, which in turn had a strong influence on the impact the SDM has on the quality of the LMS.

There is still much research to be done in this field of study that can potentially lead to the betterment of learning management systems and electronic learning as a whole.

REFERENCES

- Ali, G.E. & Magalhaes, R. 2008. Barriers to implementing e-learning: a Kuwaiti case study. *International Journal of Training and Development*, 12:36–53.
- Ambler, S.W. 2001. *The Object Primer*. 2nd ed. Cambridge: Cambridge University Press. 523 p.
- Ambler, S.W. 2008. Survey results: Agile adoption rate survey. <http://www.ambyssoft.com/surveys/agileFebruary2008.html> Date of access: 11 Feb. 2013.
- Aoyama, M. 1998. Web-based agile software. *IEEE Software*, November/December:56-65.
- Asher, H.B. 1983. *Causal modelling*. Series: quantitative applications in the social sciences. 2nd ed. London: Sage Publications. 96 p.
- Avison, D.E. & Fitzgerald, G. 1995. *Information systems development: methodologies, techniques and tools*. London: McGraw-Hill.
- Avison, D.E. & Fitzgerald, G. 2002. *Information systems development: methodologies, techniques and tools*. 3rd ed. London: McGraw-Hill. 608 p.
- Avison, D.E. & Fitzgerald, G. 2003. Where now for development methodologies?. *Communications of the Association of Computing Machinery (ACM)*, 46(1):78-82.
- Avison, D.E. & Fitzgerald, G. 2006. *Information systems development: methodologies, techniques and tools*. 4th ed. Maidenhead: McGraw-Hill. 645 p.
- Baskerville, R., Travis, J. & Truex, D. 1992. Systems without method: The impact of new methodologies on information systems development projects. (In Kendall, K.E., Lyytinen, K. & DeGross, J.I., eds.. *The impact of computer supported technologies on information systems development*, Amsterdam, 24:1-269).
- Bauer, M. SitePoint Pty. Ltd 2005. Successful web development methodologies. <http://www.sitepoint.com/successful-development/> Date of access: 20 Sept. 2013.
- Beck, L.W. 1950. Constructions and inferred entities. *Philosophy of Science*, 17(1):74-86.
- Benigno, V. & Trentin, G. 2000. The evaluation of online courses. *Journal of Computer Assisted Learning*, 16:259–270.

- Beynon-Davies, P. & Williams, M.D. 2003. The diffusion of information systems development methods. *Journal of Strategic Information Systems*, 12:29-46.
- Bianco, A.M., De Marsico, M. & Temperini, M. 2005. QUIS - quality, interoperability, and standards in e-learning: standards for e-learning. http://www2.tisip.no/quis/public_files/wp5-standards-for-elearning.pdf Date of access: 10 Sept. 2013.
- Blackboard Inc. 2013. History of Blackboard. <http://uki.blackboard.com/sites/international/globalmaster/history.html> Date of access: 12 Feb. 2013.
- Boehm, B.W. 1988. A spiral model of software development and enhancement. *IEEE Computer*, 21(5):61-72.
- Brinkkemper, S. 1996. Method engineering: engineering of information systems development methods and tools. *Information and Software Technology*, 38:275-280.
- Brits, W. 2011. The relationship between organizational and national culture and the use and effectiveness of systems development methodologies, Dissertation – M.Sc.
- Broadbent B. 2002. ABCs of e-learning: reaping the benefits and avoiding the pitfalls. San Francisco: Jossey-Bass / Pfeiffer. 256 p.
- Brown, A.W. 2000. Large-scale component-based development. New Jersey: Prentice Hall. 300 p.
- Bruen, C. & Conlan, O. 2002. Adaptive ICT support for learning styles - A development framework for re-useable learning resources for different learning styles & requirements. *ITTE Ann. Conf. Assoc. Inf. Tech. Teach. Edu.*
- Burke, M.E. 2007. Making choices: research paradigms and information management. *Library Review*, 56(6):476-484.
- Caplan, S.E. 2002. Problematic internet use and psychosocial well-being: development of a theory-based cognitive-behavioral measurement instrument. *Computers in human behavior*, 18(5), 553-575.
- Caralli, R. A. 2004. The critical success factor method: establishing a foundation for enterprise security management. *Technical report for the U.S. Department of Defense*. <http://www.sei.cmu.edu/reports/04tr010.pdf> Date of access: 10 Oct. 2013.

- Chatzoglou, P.D. & Macaullay, L.A. 1996. Requirements capture and IS methodologies. *Information Systems Journal*, 6:209-225.
- Clark, R.C. & Mayer, R.E. 2003. E-learning and the science of instruction: proven guidelines for consumers and designers of multimedia learning. San Francisco: Pfeiffer. 322 p.
- Clark, R.C. & Mayer, R.E. 2008. E-learning and the science of instruction: proven guidelines for consumers and designers of multimedia learning. 3rd ed. San Francisco: Pfeiffer. 528 p.
- Cohen, J. 1988. Statistical power analysis for behavioural sciences. 2nd edition. Hillsdale, NJ: Erlbaum. 580 p.
- Cohen, L., Manion, L. & Morrison, K. 2011. Research methods in education. 7th ed. New York: Routledge. 784 p.
- Comley, P. 2002. Online surveys and internet research. http://www.virtualsurveys.com/papers/paper_1.asp Date of access: 20 Apr. 2013.
- Connors, D.T. 1992. Software development methodologies and traditional and modern information systems. *Software Engineering Notes*, 17(2):43-49.
- Conole, G. & Oliver, M. eds. 2007. Contemporary perspectives in e-learning research: themes, methods and impact on practice. New York: Routledge. 264 p.
- Conradie, P.W. 2010. The use and effectiveness of information system development methodologies in health information systems, Thesis – PhD.
- Cyber Media Creations LLC. 2008. Elearning glossary. <http://www.cybermediacreations.com/elearning/glossary.html> Date of access: 10 Sept. 2013.
- Daniel, D. R. 1961. Management information crisis. *Harvard Business Review*, 39(5):111-121.
- Dietrich, G.B., Walz, D.B. & Wynekoop, J.L. 1997. The failure of SDT diffusion: A case for mass customisation. *IEEE Transactions on Engineering Management*, 44(4):390-398.

Dillman, D. A. 2011. Mail and Internet surveys: The tailored design method. 2007 update with new Internet, visual, and mixed-mode guide. 2nd ed. New Jersey: John Wiley & Sons. 544 p.

Dublin, L. 2003. If you look under the street lamp...or nine e-learning myths. (*In* Brandon, W.R., ed. Best of the eLearning Guild's Learning Solutions. 1st ed. San Francisco: Pfeiffer. pp. 3-12).

EduTechWiki. 2013. Learning object metadata standard.
http://edutechwiki.unige.ch/en/Learning_Object_Metadata_Standard Date of access: 10 Sept. 2013.

Ellis, R. K. 2009. Learning Circuits: a field guide to learning management systems. *American Society for Training & Development*.
http://www.astd.org/~media/Files/Publications/LMS_fieldguide_20091 Date of access: 20 Sept. 2012.

Ellis, S.M. & Steyn, H.S. 2003. Practical significance (effect sizes) versus or in combination with statistical significance (p-values). *Management Dynamics*, 12(4):51-53.

Emarketer Inc. 2013. Ecommerce sales topped \$1 trillion for first time in 2012.
<http://www.emarketer.com/Article/Ecommerce-Sales-Topped-1-Trillion-First-Time-2012/1009649> Date of access: 18 Oct. 2013.

Emory, C.W. & Cooper, D.R. 1991. Business research methods. 4th ed. Homewood, IL: Irwin. 760p.

Fardoun, H. M., & Alghazzawi, D. M. 2012. New e-learning system methodology. *Proceedings of the 2012 International Conference on Information Human Computer Interaction & Learning Technologies*, 30-31 March. Abi Dhabi, UAE.

Feldman, R., Adler, R.J. & Taqqu, M. eds. 1998. A practical guide to heavy tails: statistical techniques and applications. New York: Springer. 534 p.

Field, A. 2005. Discovering Statistics Using SPSS. London: Sage Publications. 779 p.

Fitzgerald, B. 1996. Formalized systems development methodologies: a critical perspective. *Information Systems Journal*, 6:3-23.

Fitzgerald, B., Russo, N.L. & Stolterman, E. 2002. Information systems development: methods in action. London: McGraw-Hill. 194 p.

Fitzgerald, B., Russo, N.L. & O'Kane, T. 2003. Software development method tailoring at Motorola. *Communications of the Association of Computing Machinery (ACM)*, 46(4):64-70.

Frankola, K. 2001. Why online learners drop out. *WORKFORCE-COSTA MESA-*, 80(10): 52-61.

Gallivan, M.J. 2003. The influence of software developers' creative style on their attitudes to and assimilation of a software process innovation. *Information and Management*, 40(5):443-465.

Garrison, D.R. & Anderson, T. 2003. E-learning in the 21st century: A framework for research and practice. London: RoutledgeFarmer. 184 p.

Garrison, D. R. 2011. E-learning in the 21st century: A framework for research and practice. 2nd ed. London: Taylor & Francis. 161 p.

Gauch, H.G. 2003. Scientific method in practice. Cambridge: Cambridge University Press. 457 p.

Glass, R. 1999. A snapshot of systems development practice. *IEEE Software*, 16(3):110-111.

Gilbert, L., Wang, C. & Sim, Y. W. 2005. An e-learning systems engineering methodology. *Proceedings of the 5th IEEE International Conference on Advanced Learning Technologies*, 2005:150-154.

Gillham, B. 2000. Case study research methods. New York: Continuum International Publishing Group 114 p.

Gruner, S., Klopper, R. & Kourie, D.G. 2007. Assessment of a framework to compare software development methodologies. *Proceedings of the 2007 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries*, 226:56-65.

Good, J.M. 2003. A pragmatic approach to the implementation of agile software development methodologies in plan-driven organisations. Lincoln University.

Goodman, L.A. 1985. The analysis of cross-classified data having ordered and/or unordered categories: Association models, correlation models, and asymmetry models for contingency tables with or without missing entries. *The Annals of Statistics*, 13(1):10-69.

- Henry, P. 2001. E-learning technology, content and services. *Education + Training*, 43(4/5), 249-255.
- Hirschheim, R., Klein, H.K. & Lyytinen, K. 1996. Exploring the intellectual foundations of information systems. *Accounting, Management and Information Technologies*, 6(1):1-64.
- Holmes, B. & Gardner, J. 2006. E-learning: Concepts and practice. London: Sage Publications. 200 p.
- Hopkins, J. 2000. Component primer. *Communications of the Association of Computing Machinery (ACM)*, 43(10):27-30.
- Howcroft, D. & Trauth, E. M. 2004. The choice of critical information systems research. *Information Systems Research*, 195-211.
- Hrastinski, S. 2008. Asynchronous and synchronous e-learning. *Educause quarterly*, 31(4):51-55.
- Hughes, J.A. 1990. The philosophy of social research. New York: Longman Group Limited. 169 p.
- Hughes, J. 1998. Selection and evaluation of information systems methodologies: the gap between theory and practice. *IEEE Proceedings on Software*, 145(4):100-104.
- Huisman, H.M. 1999. The deployment of systems development methodologies: A South African Experience, Thesis – PhD.
- Huisman, H.M. & livari J. 2003. Systems development use in South Africa. (*In: Galetta D., Ross J., eds. Proceedings of the 9th Americas Conference on Information Systems*, 4-6 Aug. 2003. Tampa, Florida, 1040-1052 p).
- Huisman, H.M. & livari, J. 2006. Deployment of systems development methodologies: perceptual congruence between IS managers and system developers. *Information & Management*, 43(1):29-49.
- Hull, M.E.C., Taylor, P.S., Hanna, J.R.P. & Millar, R.J. 2002. Software development process - an assessment. *Information and Software Technology*, 44:1-12.
- Humphrey, W.S. 1989. Managing the software process. Massachusetts: Addison-Wesley. 512 p.

livari, J., Hirschheim, R. & Klein, H.K. 1998. A paradigmatic analysis contrasting information systems development approaches and methodologies. *Information Systems Research*, 9(2):164-193.

livari, J., Hirschheim, R. & Klein, H.K. 1999. Beyond methodologies: Keeping up with information systems development approaches and methodologies. *Information Systems Research*, 9(2):164-193.

livari, J., Hirschheim, R. & Klein, H.K. 2000. A dynamic framework for classifying information systems development methodologies and approaches. *Journal of Management Information Systems*, 17(3):179-218.

IMS Global. 2013. About IMS global learning consortium.
<http://www.imsglobal.org/background.html> Date of access: 10 Sept. 2013.

Ingram, H., Biermann, K., Cannon, J., Neil, J. & Waddle, C. 2000. Internalizing action learning: a company perspective. Establishing critical success factors for action learning courses. *International Journal of Contemporary Hospitality Management*, 12(2):107-113.

Internet World Stats. 2013. Miniwatts Marketing Group.
<http://www.internetworldstats.com/emarketing.htm> Date of access: 11 Sept. 2013.

Jack, B. & Clarke, A. M. 1998. The purpose and use of questionnaires in research. *Professional nurse*, 14(3)176 p.

Janse van Rensburg, C.W. 2012. The relationship between process maturity models and the use and effectiveness of systems development methodologies, Dissertation – M.Sc.

Jayaratna, N. 1994. Understanding and evaluating methodologies: NIMSAD, a systematic framework. London: McGraw-Hill. 288 p.

Ketunnen, P. & Laanti, M. 2005. How to steer an embedded software project: tactics for selecting the software process model. *Information and Software Technology*, 47:587-608.

Kincheloe, J. L. & McLaren, P. 2002. Rethinking critical theory and qualitative research. *Ethnography and schools: Qualitative approaches to the study of education*, 87-138.

Kruse, K. 2004. The benefits and drawbacks of e-learning. <http://www.e-learningguru.com>
Date of access: 10 Sept. 2013.

- Kuhn, T.S. 1996. *The Structure of Scientific Revolutions*. 3rd ed. Chicago: University of Chicago Press. 211 p.
- Larman, C. 2004. *Agile and iterative development: a manager's guide*. Boston: Pearson Education Inc. 347 p.
- Learning Solutions Magazine. 2013. The XML e-Learning Revolution: Is your production model holding you back? <http://www.learningsolutionsmag.com/articles/215/the-xml-e-learning-revolution-is-your-production-model-holding-you-back> Date of access: 10 Sept. 2013.
- LeBlanc, D. C. 2004. *Statistics: concepts and applications for science*. Supplement vol. 2. London: Jones & Bartlett Learning. 382p.
- Lee, A.S. 1999. Researching MIS. (In Currie, W.L. & Galliers, R., eds. *Rethinking management information systems*. Oxford: Oxford University Press. p7 - 27).
- Lee, D.T. 1987. Computer information system development methodologies: A comparative analysis. *AFIPS Conference Proceedings*, 56:683-692.
- Lee, S.C. & Shirani, A.I. 2004. A component-based methodology for web application development. *The Journal of Systems and Software*. 71:177-187.
- Leontitsis, A. & Pagge, J. 2007. A simulation approach on Cronbach's alpha statistical significance. *Mathematics and Computers in Simulation*, 73(5):336-340.
- Littlejohn, A. & Pegler, C. 2007. *Preparing for blended e-learning*. New York: Routledge. 243 p.
- Lovelace, P. 1999. CUNA explores web-based learning. *Credit Union Magazine*, 65(2):29–30.
- Lowry, R. 1999. T-test for the significance of the difference between the means of two independent samples.
- Martinez, M. 2003. High attrition rates in e-learning: challenges, predictors and solutions. *The E-Learning Developers' Journal*, 14.
- Mayer, R.E. 2009. *Multimedia learning*. 2nd ed. New York: Cambridge University Press. 318 p.

Mayer, R.E. 2011. E-Learning: new opportunities and a view of the future. *The Oxford Handbook of Lifelong Learning*: 263 p.

Merriam-Webster dictionary. 2013. Empirical. <http://www.merriam-webster.com/dictionary/empirical> Date of access: 31 Aug. 2013.

Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J. & ID2 Research Group. 1996. Reclaiming instructional design. *Educational Technology*, 36(5):5-7.

Moodle Trust. 2013. About Moodle. http://docs.moodle.org/25/en/About_Moodle Date of access: 12 Sept. 2013.

Monahan, T. 2004. Just another tool? IT pedagogy and the commodification of education. *Urban Review*, 36(4):271-292.

Morrison, G. R., Ross, S. M., Kemp, J. E., & Kalman, H. 2010. Designing effective instruction. 6th ed. New Jersey: John Wiley & Sons. 491 p.

Moshinskie, J. 2001. How to keep e-learners from e-scaping. *Performance Improvement*, 40(6):30-37.

Murugesan, S. 1999. Editorial. *ACM SIGWEB Newsletter*, 3:3.

Myers, M.D. & Avison, D., eds. 2002. Qualitative research in information systems: A reader. London: Sage Publications. 314 p.

Nantel, R. 2009. Brandon Hall Research: 100 commercial learning management systems. <http://brandon-hall.com/richardnantel/2009/07/17/100-commercial-learning-management-systems/> Date of access: 16 Sept. 2012.

Nebulon Pty. Ltd. 2013a. Feature driven development. <http://www.nebulon.com/articles/fdd/download/fddoverview.pdf> Date of access: 10 Oct. 2013.

Nebulon Pty. Ltd. 2013b. The latest FDD processes. <http://www.nebulon.com/articles/fdd/latestfdd.html> Date of access: 10 Oct. 2013.

Nerur, S., Mahapatra, R. & Mangalaraj, G. 2005. Challenges of migrating to agile methodologies. *Communications of the Association of Computing Machinery (ACM)*, 48(5):72-78.

Newsted, P.R., Huff, S.L. & Munro, M. 1998. Survey instruments in information systems. *MIS Quarterly*, 22(4):553-554.

Nulty, D. D. 2008. The adequacy of response rates to online and paper surveys: what can be done?. *Assessment & Evaluation in Higher Education*, 33(3):301-314.

Oates, B.J. 2006. Researching information systems and computing. London: Sage Publications. 341 p.

Olivier, M.S. 2009. Information technology research: a practical guide for computer science and informatics. Van Schaik.

Open Source Initiative. 2012. The open source definition. <http://opensource.org/osd> Date of access: 12 Sept. 2012.

Oxford English Dictionary. 2013. Oxford: Oxford University Press.

Papp, R. 2000. Critical success factors for distance learning. Paper presented at the Americas Conference on Information Systems, Long Beach, CA, USA.

Paulsen, M.T. 2002. Online education systems: discussion and definition of terms. *NKI Distance Education*. Jul. 2002.

<http://www.porto.ucp.pt/open/curso/modulos/doc/Definition%20of%20Terms.pdf> Date of access: 10 Sept. 2013.

Pfleeger, S.L. 1999. Understanding and improving technology transfer in software engineering. *Journal of Systems and Software*, 47(2):111-124.

Piskurich, G. M. 2006. Rapid instructional design: learning ID fast and right. 2nd ed. San Francisco: John Wiley & Sons. 508 p.

Punch, K.F. 1998. Introduction to social research: quantitative and qualitative approaches. London: Sage Publications. 319 p.

Reifer, D.J. 2002. How good are agile methods?. *IEEE Software*, 19(4):16-18.

Rockart, J. F. 1979. Chief executives define their own data needs. *Harvard business review*, 57(2)81-93.

- Russo, N., Wynekoop, J. & Walz, D. 1995. The use and adaptation of systems development methodologies, in Khosrowpour, M., ed. *Managing Information and Communications in a Changing Global Environment*, Idea Group Publishing, PA.
- Saba Software Inc. 2013. About us. <http://www.saba.com/us/about/> Date of access: 10 Oct. 2013.
- Saeki, M. 1998. A meta-model for method integration. *Information and Software Technology*, 39:925-932.
- Sakai Foundation. 2013. About Sakai. <http://www.sakaiproject.org/about-sakai> Date of Access. 18 Sept. 2013.
- Schach, S.R. 1997. *Software engineering with Java*. 4th ed. London: McGraw-Hill. 640 p.
- Schwalbe, K. 2010. *Information technology: project management*. 6th ed. Boston: Cengage Learning. 672 p.
- Selim, H. M. 2007. Critical success factors for e-learning acceptance: Confirmatory factor models. *Computers & Education*, 49(2):396-413.
- Shine Technologies Pty Ltd. 2003. Agile methodologies - Survey results: Agile methodologies. http://www.shinetech.com/agile_survey_results.jsp Date of access: 11 Feb. 2013.
- Siau, K. & Rossi, M. 1998. Evaluation of information modeling methods: A review, *Proceedings of the thirt-first Hawaii International Conference on System Sciences*, 5:314-322.
- Simpson, B. 2009. Open source LMS – 10 alternatives to Moodle. <http://barrysampson.com/2009/04/open-source-lms-10-alternatives-to-moodle/> Date of Access: 10 Sept. 2013.
- Srinagesh, K. 2006. *The principles of experimental research*. Oxford: Butterworth-Heinemann. 432 p.
- Statsoft Inc. 2013. Electronic statistics textbook. How to analyze data with low quality or small samples, nonparametric statistics. <https://www.statsoft.com/Textbook/Nonparametric-Statistics> Date of access: 28 Oct. 2013.

- Szyperski, C. 1998. *Component software: beyond object-oriented programming*. New York: ACM Press. 411 p.
- Tabachnick, B.G. & Fidell, L.S. 2001. *Using multivariate statistics*. 4th ed. Boston: Allyn & Bacon. 966p.
- Thomas H. 1989 *Distributions of correlation coefficients*. London: Springer. 95 p.
- Training Industry, Inc. 2013. ADDIE model.
<http://www.trainingindustry.com/wiki/entries/addie-model.aspx> Date of access: 18 Oct. 2013.
- Truex, T., Baskerville, R., & Travis, J. 2000. Amethodical systems development: the deferred meaning of systems development methods. *Accounting and Information Technologies*, 10(1):53-79.
- Tull, D.S. & Hawkins, D.I. 1987. *Marketing research: measurement and method*. 4th ed. New York: MacMillan. 816p.
- Vavpotic, D. & Bajec, M. 2009. An approach for concurrent evaluation of technical and social aspects of software development methodologies. *Information and Software Technology*, 51(2):528-545.
- Vitharana, P. 2003. Risks and challenges of component-based software development. *Communications of the Association of Computing Machinery (ACM)*, 46(8):67-72.
- Vitharana, P., Zahedi, F. & Jain, H. 2003. Design, retrieval and assembly in component-based software development. *Communications of the Association of Computing Machinery (ACM)*, 46(11):97-102.
- Wagner, E.D. 2002. The new frontier of learning object design. *The E-learning Developer's Journal*, Jun(2002):1-7.
- Wagener, R. 2012. Investigating critical success factors in agile systems development projects, Dissertation – M.Sc.
- Walters, S.A., Broady, J.E. & Hartley, R.J. 1994. A review of information systems development methodologies. *Library Management*, 15(6):5-19.
- Weller, M. 2007. *Virtual learning environments: using, choosing and developing your VLE*. New York: Routledge. 192 p.

Welsh, E. T., Wanberg, C. R., Brown, K. G. & Simmering, M. J. 2003. E-learning: emerging uses, empirical results and future directions. *International Journal of Training and Development*, 7: 245–258.

WorldWideLearn. Quinstreet Inc. 2013. Benefits of e-learning.
<http://www.worldwidelearn.com/elearning-essentials/elearning-benefits.htm> Date of access:
10 Sept. 2012.

Wynekoop, J.L. & Russo, N.L. 1993. Studying systems development methodologies: Unanswered questions and the research gap. (In DeGross, J.I. et al., eds. *Proceedings of the Fourteenth International Conference on Information Systems, Orlando, FL*, p. 181-190).

Wynekoop, J.L. & Russo, N.L. 1995. Systems development methodologies: unanswered questions. *Journal of Information Technology*. 10(2):65-73.

Wynekoop, J.L. & Russo, N.L. 1997. Studying systems development methodologies: an examination of research methods. *Information Systems Journal*, 7:47-65.

ADDENDUMS

Addendum A – Questionnaire

A Study on the use and effectiveness of System Development Methodologies in developing E-Learning Systems

(please mark with an "X" in the boxes that are applicable to you in the light-red sections)
(click on textbox at the bottom of this page to submit the questionnaire)

Section 1: Background Information

1. Which of the following best describe the industry you work in?

1.1	Academic	
1.2	Government	
1.3	Private Sector	
1.4	Other, please specify: <input type="text"/>	

2. Do you use any type of electronic learning for education or training purposes at the company you are employed at?

2.1	Yes	
2.2	No	
2.3	Not sure, reason: <input type="text"/>	

3. What role best describes your involvement with, e-learning or online training programmes? (You can select more than one)

3.1	Not involved	
3.2	User (Learner/Trainee)	
3.3	Teacher	
3.4	Facilitator	
3.5	Trainer	
3.6	Coordinator	
3.7	Developer	
3.8	Project leader	
3.9	Project member	
3.10	Involved in deployment	
3.11	Involved in user support	
3.12	Other, please specify: <input type="text"/>	

4. How many students/learners/employees use the e-learning system for learning/training purposes?

4.1	1-99	
4.2	100-499	
4.3	500-999	
4.4	1000 - 4999	
4.5	5000 - 9999	
4.6	10 000 or more	

Section 2: The E-learning System

5. To the best of your knowledge, do you use a proprietary (Blackboard, SharePoint LMS or any self-developed system) or an open-source (SAKAI, Moodle) e-learning system?

5.1	Proprietary, please specify:	
5.2	Open-source, please specify:	
5.3	Other, please specify:	

6. Which of the following best describes the procurement of the e-learning system?

6.1	Purchased	
6.2	Developed in-house	
6.3	Outsourced	
6.4	Open-source (used as-is), specify which:	
6.5	Adapted from open-source system, specify which:	

7. In the case of a open-source system: Did your organisation help develop any of the tools or resources that is being utilised in the e-learning system?

7.1	Yes, please name examples:	
7.2	No	
7.3	Not sure	

8. Which of the following best describes the online availability of your e-learning system?

8.1	Available online for access outside your organisation	
8.2	Available only within the intranet of the organisation	

9. To what extent do you agree with the following statements about the most recent e-learning system you were involved with?

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
9.1	The system is functional					
9.2	The system is reliable					
9.3	The system is maintainable					
9.4	The system is portable					
9.5	The system is efficient					
9.6	The system is usable					
9.7	The developed system meets user needs					
9.8	The documentation of the developed system is good					
9.9	Overall, the developed system is of high quality					
9.10	Overall, the users are satisfied with the developed system					
9.11	Overall, the developed system is a success					

10. To what extent do you agree with the following statements regarding your e-learning platform (open-source vs. proprietary)?

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
10.1	I'm totally satisfied with our current platform					
10.2	I would consider using a open-source e-learning system for future projects					
10.3	I would consider purchasing a proprietary e-learning system for future projects					
10.4	I would consider the in-house development of an e-learning system for future projects					

11. How do you rate the following identified critical success factors (CSF's) of e-learning systems in terms of their importance?

		Not Important	Slightly Important	Important	Very Important
11.1	Instructor Involvement (characteristics, attitude towards learners, e-skills literacy, ability to encourage learners to participate)				
11.2	Student Computer Competency (Ability to use and promote computing technology as it is applied to learning)				
11.3	Student Collaboration (Student-student / Student-instructor)				
11.4	E-learning Course Content and Design (Student's perception about interactivity, efficiency and effectiveness of e-learning system)				
11.5	Technology (Ease of access and navigation, visual technology interface and IT infrastructure reliability and effectiveness)				
11.6	University/Company support to e-learning initiatives (library services, help desk, computer labs and facilities)				
11.7	E-Learning Usage Factor (intention of registering in future e-based courses, student's perception about e-learning in general)				

Section 3: System Development Methodologies used with the development of the E-learning System

12. If the e-learning system was developed in-house (or if you developed tools for use with a open-source e-learning system), did you use any formal system development methodologies to aid in the development?

12.1	Yes	
12.2	No	

13. How many staff do you have on your development team?

13.1	1-5	
13.2	6-10	
13.3	11-20	
13.4	21 or more	

14. To what extent did you use the following (standard) system development methodologies in developing your e-learning system or tools therefor?

		Not At All	To Small Extent	Too large Extent	To Full Extent
14.1	STRADIS (Structured Analysis, Design & Implementation of Information Systems)				
14.2	OOA (Object-oriented Analysis)				
14.3	RUP (Rational Unified Process)				
14.4	XP (Extreme Programming)				
14.5	RAD (Rapid Application Development)				
14.6	ETHICS (Effective Technical & Human Implementation of Computer-based Systems)				
14.7	IE (Information Engineering)				
14.8	SSM (Soft Systems Methodology)				
14.9	Other, specify: <input type="text"/>				

15. Which of the following best describes how stringently you made use of the system development methodology?

15.1	As a general guideline only	
15.2	Adapted it depending on the project	
15.3	Implemented it rigorously	

16. To what extent do you agree with the following statements?

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
16.1	Using a system development method is recommended in my work					
16.2	The result of using a system development methodology is clear to me					
16.3	I would be able to communicate to others the consequences of using a system development methodology					
16.4	I would be able to explain why using a system development methodology may or may not be beneficial					
16.5	The application of the system development methodology is clear to me					
16.6	The benefits of using the system development methodology is apparent					
16.7	Overall, I believe the system development methodology is user-friendly and easy to apply					
16.8	The system development methodology enable me to complete tasks quicker					
16.9	The quality of my work is improved by using the system development methodology					
16.10	It is easier to accomplish my work by using the system development methodology					
16.11	The effectiveness of my work in systems development was enhanced using a system development methodology					
16.12	I had greater control over my development work when using a system development methodology					
16.13	The system development methodology is compatible with my development work					
16.14	The system development methodology fits well in the way I like to work					
16.15	I was permitted to use the system development methodology on a trial basis to see what it can do					

17. To what extent do you agree with the following statements?

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
17.1	The system development methodology was effective in the design process of the proposed system					
17.2	The system development methodology was effective in implementing the developed system					
17.3	The system development methodology was effective in testing the developed system					
17.4	The system development methodology was effective in reuse of components developed in previous systems					
17.5	The system development methodology helped to get the developed system accepted					

18. To what extent do you agree with the following statements in regards with the end-user E-learning system?

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
18.1	The e-learning system is more functional as result of using the system development methodology					
18.2	The e-learning system is more reliable as result of using the system development methodology					
18.3	The e-learning system is more maintainable as result of using the system development methodology					
18.4	The e-learning system is more efficient as result of using the system development methodology					
18.5	The e-learning system is of better quality as result of using the system development methodology					
18.6	The e-learning system is more useable as result of using the system development methodology					
18.7	The users of the e-learning system is more satisfied as result of using the system development methodology					

19. Which best reflects your opinion on the use of system development methodologies for future projects?

19.1	Will use it again, as is	
19.2	Will adapt it to suit the needs of the project	
19.3	Will supplement it with other methodologies	
19.4	Will replace it with a better suited methodology	
19.5	Will not use a system development methodology again	
19.6	Other, please specify: <input type="text"/>	

**20. What is the reason(s) for not using a systems development methodology?
To what extent do you agree with the following statements?**

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
20.1	My organisation/IS department doesn't require the use of system development methodologies					
20.2	System development methodologies are complex or difficult to use					
20.3	Our current processes for development are adequate					
20.4	The benefits of using system development methodologies are not extensive enough					
20.5	The initial cost of procuring a system development methodology are high					
20.6	There is a lack of staff experienced in system development methodologies to implement such a strategy					
20.7	There is a lack of management support for the use of system development methodologies					

21. What is your opinion on a newly developed system development methodology designed specifically for e-learning systems? Indicate to what level you agree with the following statements

		Totally Disagree	Disagree	Neutral	Agree	Totally Agree
21.1	There is room for a newly designed SDM specifically for developing e-learning systems					
21.2	An existing SDM can be adequately adopted to suit the needs of e-learning, please specify: _____					
21.3	E-learning systems are a special type of IS and requires an unique system development methodology					
21.4	E-learning systems can benefit from using a system development methodology					

22. Will you be available for any follow-up questions or any future questionnaires? (Your time is valuable and you will not be contacted unnecessarily. The results of this study will also be made available to participants)

22.1	Yes	
22.2	No	

(Click on this textbox to automatically email this questionnaire)

THANK YOU!

For any queries please contact: [email]

If your email client doesn't support automatic emails or your Excel macros are disabled, please save file and send to: [email]

(Click on this textbox to automatically email this questionnaire)

ADDENDUM B – EMAIL TO CANDIDATE RESPONDENTS

Dear [Reader],

I hope all is well with you.

[Reader], I got your contact details from a colleague of mine and I can promise you that **I don't intend on spamming** you or giving out your email address.

I would GREATLY appreciate it, if you and your team can take **5 minutes** of your time in this regard.

I do **research at the North-West University** and are busy looking at the SA culture of **e-learning development and methodologies** used.

I have a VERY short survey targeting developers, project leaders, programmers, (basically anybody involved in e-learning and the development thereof), etc. Firstly to get an idea how e-learning development takes place in SA and secondly to (hopefully) improve on current methods, shed some light on methodologies etc., and to find out if the SA market develops in-house, use open-source LMS, or procure a ready-made product.

I would REALLY appreciate it, if you or anybody else you might know that does work in this field, can complete it.

I would gladly share my research results at the end of the study.

I'm **targeting a very niche market**, thus every single survey I can get back will be GREATLY appreciated.

Thanks for your time!

Regards
Kobus van Aswegen

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