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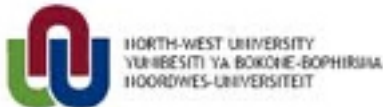
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# To use or not to use? SDM utilisation in the development of LMS in South Africa

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## Abstract

**Purpose** – The purpose of this study was to determine if Systems Development Methodologies (SDMs) are being utilised effectively in the development of Learning Management Systems (LMSs) in South Africa. With e-learning being a critical component of modern educational systems, it has become essential to ensure that LMSs of a high standard are being developed. In the field of SDMs, much research has been done and the value of SDMs is proven and documented. To enhance the chances of developing LMSs of outstanding quality, it is crucial that SDMs are applied efficiently, as they can have a significant impact on the development process.

**Design/methodology/approach** – A positivistic research approach was followed. By utilising a survey as the main research method, quantitative data were generated. By statistically analysing the dataset, meaningful results were obtained.

**Findings** – This study shed some light on how LMS 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 SDMs (e.g. Rapid Application Development) are being used effectively in the development of e-learning systems. Strong relationships exist between many of the SDM 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 SDMs have on the quality of LMSs.

**Originality/value** – The study made a contribution to the discipline of information systems and, more specifically, LMSs, by providing insights with regard to the factors affecting the use and effectiveness of SDMs in developing LMSs. As far as could be ascertained, this study generated the first empirical data on the procurement and development of LMSs in South Africa.

**Keywords** Research, E-learning, Information systems

**Paper type** Research paper



## 1. Introduction and problem statement

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.

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.

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

More traditional methods of education have evolved over centuries and considerable time and effort have gone into developing the teaching methods being used 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.

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. 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 past 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.

The aim of this study was to research the use and effectiveness of SDMs in the development of LMSs.

## 2. Terminology: e-learning

This section gives a background on what is implied by the terms e-learning and e-learning systems and confers the difference between open-source and proprietary e-learning systems.

### 2.1 Definition of e-learning

Over the past 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.

There are many disparate definitions of e-learning but for the purposes of this study, e-learning can be seen as a medium for delivering and facilitating learning, through electronic means.

### 2.2 Learning management systems

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. 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 online and to facilitate the learning experience around that content. This is also the definition that will be used for the purposes of this study.

When procuring an e-learning system one can divide the options into two main groups, namely: proprietary or open-source. Open-source software is getting increasingly popular due to the economical and modular benefits it can offer. There is a

number of open-source LMS software available but the two that have the greatest market share are Sakai and Moodle.

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

### 3. Literature study: SDMs

The aim of this section is to give a review of SDMs. First, a brief overview on the background of SDMs will be given, then a clarification of the definition of SDMs will be made.

#### 3.1 Background

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

Huisman and Iivari (2006) argued that using a systems develop 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.

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.

#### 3.2 Definition

There has been much contention over the precise definition of the term SDM. 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 are: an SDM 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). 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.

The following definition of an SDM Huisman (1999) best disseminates the meaning of an SDM and will be used for the purposes of this study:

- *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 (Iivari *et al.*, 1998; Iivari *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 and 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 (Iivari *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 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 an SDM.

### 3.3 The use of SDMs

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, while improving productivity and quality (Fitzgerald *et al.*, 2002). Whether SDMs are being used in practice has been a point of interest for academics for an extended period.

Russo *et al.* (1995) found that only 6 per cent of developers followed an SDM rigorously. Chatzoglou and Macaullay (1996) found that 47 per cent of their population had never used a methodology. Avison and Fitzgerald (2003) also found this number to be low. Less than 50 per cent 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). However, in recent studies conducted by Brits (2011) and Janse van Rensburg (2012), it was found that 74 per cent of organisations in South Africa make use of SDMs. Conradie (2010) and Wager (2012) also found this number to be above 75 per cent.

Other research shows that SDMs 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): First, organisations are under pressure to maintain their competitiveness by adhering to international standards as set by the

International Organisation of Standards (ISO). Second, 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. Third, some governments are enforcing systems development standards. By doing so, they force organisations that deliver software to them, to use the appropriate SDM.

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, 2001; 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 Iivari (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.

### 3.4 *The effectiveness of SDMs*

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 past 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. They 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. Fitzgerald *et al.* (2002) state that SDMs 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 *et al.* (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 ensuing more consistent outcomes. The use of software methodologies is said to decrease the risk of failure of an information system (IS) project (Hull *et al.*, 2002; Avison and Fitzgerald, 2003).

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 1990s (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. Data collection and analysis

In the field of ISs, surveys are a popular strategy to employ in the collection of empirical evidence. A questionnaire, as the measurement element, was developed in collaboration with a statistical consultation service. The constructs, identified from the conceptual research model, were operationalised by selecting measurement scale items (questions) and scale types. The questions were adapted from previous research studies, which proved to be reliable. The questionnaire was concise and relevant and contained mostly leading, importance and 5-point Likert scale questions. It was distributed electronically, as a macro-enabled Excel file, 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 had extensive built-in entry validation to ensure that the respondents fill in the correct values as well as coding to assist in data analysis.

Fifty responses were received from a possible 175 responses. Therefore, the participation rate equalled 40 per cent with 50 cases available for data analysis.

For this study, a combination of statistical techniques (such as, describing the central tendency, correlation coefficients, null hypothesis and tests of significance) were used to describe the data. Factor analysis was done to reduce the amount of variables to a smaller number of factors. *t*-tests, cross-classification tables (crosstabs) and nonparametric correlations were used to determine possible relationships between the variables and factors.

## 5. Results of the survey and the research questions

### 5.1 Descriptive survey results

This section gives a summary of the general results obtained from all the respondents that completed the survey:

- *Industry the respondents work in:* Just fewer than 60 per cent of the respondents stated that the type of industry they work in can be described as “Academic”. The rest (40.43 per cent) were in the “Private Sector”.
- *Number of learners, students or employees:* Almost 58 per cent of the LMSs are being used to train or educate 10,000 or more people.
- *LMS platform:* Almost 60 per cent of respondents use an open-source LMS environment and not proprietary.
- *Procurement method of LMS:* 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 per cent of the respondents indicated that they adapted their current LMS from an open-source based LMS. See [Table I](#).
- *Perceived success of the LMS:* Respondents were asked to what extent they agree on statements regarding their current LMS. An overwhelming 84.91 per cent of the respondents answered in the affirmative, by marking either “Agree” or “Totally Agree”, on the different options of this question that presented perceived success of their LMS.
- *The extent and stringent use of formal SDMs:* Respondents were asked to indicate whether they used formal SDMs to aid in systems development. Almost 80 per cent indicated that they use formal SDMs in development. Object-Oriented Analysis (OOA) and Rapid Application Development (RAD) were most frequently selected, with 47.06 per cent and 38.24 per cent of the respondents respectively, using it to a large extent. Almost 60 per cent of the respondents indicated that they adapted the SDM they used, depending on the specific project requirements.
- *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 per cent of the respondents agreed and about 12 per cent totally agreed that the e-learning system was more reliable as result of using an SDM in development. On average, 58 per cent[1] 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.

Procurement method	(%)
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 I.**  
Procurement method of  
LMS

- *The need for an LMS-specific SDM:* With this question, 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. Almost 75 per cent of the respondents agreed that there was room for a newly designed SDM for developing LMSs.

### 5.2 Interpretive results of the research questions

This study aims to explore and understand the factors that influence the use and effectiveness of SDMs in developing LMSs. In trying to meet this aim, the researchers set themselves the following research questions (RQs):

- *The relationship between industry and platform of the LMS (RQ1):* In academic institutions open-source LMSs are being used in almost 61 per cent of the cases and in the private sector just above 52 per cent. Many of the academic institutions indicated that they are in the process of moving towards an open-source LMS but that they are currently still using a proprietary LMS.
- *The relationship between industry and number of students (RQ2):* Crosstab analysis was done to determine if the type of industry relates to the number of users of the specific LMS in question. The results of the crosstab analysis can be seen in [Table II](#), and it was statistically significant with  $p < 0.01$  and a Cramer's V of 0.568.
- It is quite noticeable that 75 per cent 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.
- *The relationship between industry and method of procurement of LMS (RQ3):* Crosstab analysis was done to determine if the type of industry relates to the LMS platform being used. The results of the crosstab analysis can be seen in [Table III](#), and it was statistically significant with  $p < 0.05$  and a Cramer's V of 0.447.
- 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

Industry	No. of students/learners/employees using the LMS						Total
	1-99	100-499	500-999	1000-4999	5000-9999	10,000 or more	
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 II.**  
Crosstab analysis: RQ2

Industry	Purchased	In-house	Procurement of LMSs		Total
			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 III.**  
Crosstab analysis: RQ3

per cent of the respondents, indicating that they make use of in-house development.

- With 32.6 per cent 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 adoption of open-source LMS, it is worth noting that 39.3 per cent of academic institutions use open-source systems “as is”, while only 5.6 per cent of the private sector use LMSs “as is”. Only 21.4 per cent of academic institutions adapt their LMSs compared to the 50 per cent of the private sector. A combined total of 23.9 per cent of the procurement of LMSs are being done by purchasing off-the-shelf products.
- *The relationship between the LMS platform and the satisfaction with the platform (RQ4):* *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 1.71, 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[2]. 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.
- *The relationship between the procurement method of the LMS and the satisfaction with the platform (RQ5):* *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 an 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  $p < 0.001$ . Respondents that use a proprietary LMS would be inclined to consider using an 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 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.
- *The relationship between the perceived success of the LMS and the satisfaction of the platform (RQ6):* There is a 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  $p < 0.001$ .

- *The relationship between the type of SDM used and the success of the LMS (RQ7):* *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,  $p < 0.05$ .
- *The relationship between the type of SDM used and the impact of the SDM on the development process (RQ8):* This RQ 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. 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. Spearman's  $\rho = 0.618$ ,  $p < 0.001$ . There is a 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  $\rho = 0.517$ ,  $p < 0.01$ . The SDM with the strongest influence on the quality and productivity of the development process is RAD, which is an Agile methodology.
- *The relationship between the performance expectancy of the SDM and the impact of the SDM on the quality and productivity of the development process (RQ9):* 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  $p < 0.01$ .
- *The relationship between the performance expectancy of the SDM and the perceived impact of the SDM on the quality of the LMS (RQ10):* 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  $p < 0.01$ .
- *The relationship between the perceived support that the SDM provides and the impact of the SDM on the quality and productivity of the development process (RQ11):* 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  $p < 0.001$ .
- *The relationship between the perceived support that the SDM provides and the perceived impact of the SDM on the quality of the LMS (RQ12):* 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  $p < 0.01$ .
- *The 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 (RQ13):* 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  $p < 0.01$ .
- *The relationship between the perceived impact of the SDM on the quality of the LMS and the success of the LMS (RQ14):* 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  $p < 0.05$ .

- *The need to design an SDM specific to LMS and the SDM that was used to develop the current LMS (RQ15):* There is a strong negative relationship that exists between respondents that indicated that they use another (not listed) SDM and on the 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 adopted to suit the needs of e-learning systems with a Spearman's  $\rho = 0.437$  and a statistical significance,  $p < 0.01$ . There is a moderate negative relationship that exists between the respondents that indicated that they use IE as SDM, and the opinion that an existing SDM can be adequately adopted to suit the needs of e-learning with a Spearman's  $\rho = -0.399$  and a statistical significance,  $p < 0.05$ .
- *Summary of the results:* A summary of the statistical analyses that were performed, and the relationships that were evaluated, can be seen in [Table IV](#).

## 6. Conclusion

The descriptive statistics that are presented in this paper reveal some interesting facts about LMSs in South Africa and the use of SDMs when developing LMSs.

Both academic institutions and the private sector were approached to participate in this study. 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 and that they use an open-source LMS. Almost one-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.

Almost 80 per cent of the respondents 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 OOA and RAD, 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. It does seem as though organisations involved in developing e-learning systems are not using SDMs 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.

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

Research question	Path tested	Spearman's ( $\rho$ )/ Cramer's V ( $\varphi$ )	Effect size ( $f^2$ )	Relationship/correlation/level of association
<i>RQ1</i>	Industry → Platform_Used	$\varphi_c = 0.709^{***}$	n/a	Very strong
<i>RQ2</i>	Industry → Number_Users	$\varphi_c = 0.568^{**}$	n/a	Very strong
<i>RQ3</i>	Industry → Procurement_LMS	$\varphi_c = 0.447^*$	n/a	Very strong
<i>RQ4</i>	Platform_Used → Satisfaction_LMS_Platform	n/a	1.71*** 1.04***	Very high effect
<i>RQ5</i>	Procurement_LMS → Satisfaction_LMS_Platform	n/a	2.11*** 2.16*** 1.50*** 1.45***	Very high effect
<i>RQ6</i>	Success LMS → Satisfaction_LMS_Platform	$\rho = 0.589^{***}$	n/a	Strong
<i>RQ7</i>	Formal_SDM_Use → Success_LMS	n/a	0.34*	Moderate
<i>RQ8</i>	Extent_Standard_SDM (RAD) → Impact_SDM_Quality_Productivity	$\rho = 0.618^{***}$	n/a	Very strong
<i>RQ9</i>	Performance Expectancy_SDM → Impact_SDM_Quality_Productivity	$\rho = 0.563^{**}$	n/a	Strong
<i>RQ10</i>	Performance Expectancy_SDM → Impact_Quality_LMS	$\rho = 0.547^{**}$	n/a	Strong
<i>RQ11</i>	Perceived Support_SDM → Impact_SDM_Quality_Productivity	$\rho = 0.744^{***}$	n/a	Very strong
<i>RQ12</i>	Perceived Support_SDM → Impact_Quality_LMS	$\rho = 0.541^{**}$	n/a	Very strong
<i>RQ13</i>	Impact_SDM_Quality_Productivity → Impact_Quality_LMS	$\rho = 0.543^{**}$	n/a	Strong
<i>RQ14</i>	Impact_Quality_LMS → Success LMS	$\rho = 0.376^*$	n/a	Moderate
<i>RQ15</i>	Need_SDM_LMS → Extent_Standard_SDM (Other)	$\rho = 0.437^{**}$	n/a	Strong

**Notes:**  $\rho$  = level of significance; \*\*\* = < 0.001; \*\* = < 0.01; \* = < 0.05; n/a = this type of test could not/was not performed

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.

Almost three quarters of the respondents felt that there may be room for a newly designed SDM that could enhance their LMS development work.

The inferential statistics that are presented in this paper reveal some thought-provoking facts about the relationships between certain constructs related to LMSs and SDMs in South Africa.

Crosstab analysis indicated that open-source LMSs are preferred to proprietary LMSs, especially in the academic sector. 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 a 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 are more 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.

A very strong relationship was found 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 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.

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.

The study made a contribution to the discipline of ISs, and more specifically, LMSs, by providing insights with regard to the factors effecting the use and effectiveness of SDMs in developing LMSs. 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.

Almost 75 per cent 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 also serve as a stimulus for future research in the field of LMSs and more specifically the development of LMSs by using SDMs to enhance the chances of success for those systems.

### Notes

1. This percentage was calculated by adding the Agree and Totally Agree columns and averaging all the variables across the complete question.
2. All the means are indicated as a value out of a possible 5, as a 5-point Likert scale was used.

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