

# IDIA2018

Making ICT Research Locally Relevant



**Proceedings of the 10<sup>th</sup> Conference of the International  
Development Informatics Association (IDIA 2018)**

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Hennopsriver Valley

Tshwane

South Africa

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## Message from the Conference Chair

Welcome to the 10th International Development Informatics Association Conference (IDIA 2018). I trust that you will experience an informative and inspiring conference at La Wiida Lodge in the beautiful Hennopsriver Valley of the Gauteng province in South Africa.

The goal of IDIA conferences is to provide delegates with an opportunity to share ideas, focusing on research on the use of ICT for developing economies and societies (ICT4D), where various constraints impact on the use of ICT compared to highly developed regions. IDIA aims to balance the need for a high level of academic input from all involved with the need to develop emerging researchers. This 10th IDIA conference offers the opportunity to look back, take stock and debate the way ahead. The accepted papers reflect the local and international discourses in ICT4D, in keeping with the IDIA 2018 theme, *Making ICT Research Locally Relevant*.

We are fortunate to have an international keynote speaker from, Judge Business School, University of Cambridge, Prof Geoff Walsham. In addition, we co-hosted an IFIP 9.4 Masters and Doctoral Symposium for Sub-Saharan Africa (Southern and Eastern). This was chaired by Prof Caroline Khene and Ms Gugu Baduza with Prof Walsham and Prof Robert Davison, IFIP 9.4 Chairperson from the City University of Hong Kong as invited speakers.

On behalf of the IDIA community, I wish to express our deepest appreciation to our sponsor, the College of Science, Engineering and Technology at the University of South Africa.

A successful conference requires the effort of many individuals. We would like to thank the members of the program committee for their hard work. We are grateful to the authors who submitted their papers to this conference and the reviewers for sharing their expertise so mindfully. I also wish to extend my sincere thanks to all members of the organising committee and congratulate them on a job well done.

We hope that the conference will provide the inspiration for new research ideas and the opportunity for making fruitful connections whilst enjoying the landscape and wildlife.

Judy van Biljon

IDIA 2018 Conference Chair

## Message from the Proceedings Chairs

Being part of a revived IDIA conference, with the theme of *Making ICT Research Locally Relevant*, has been an exciting and inspiring opportunity for us.

This year, we explored new frontiers. We successfully applied to Springer to publish selected papers as a Communication in Computer and Information Science (CCIS) volume. CCIS is abstracted/indexed in DBLP, Google Scholar, EI-Compendex, Mathematical Reviews, SCImago, and Scopus. CCIS volumes are also submitted for inclusion in ISI Proceedings. With this, IDIA 2018 has increased its international reach and standing.

The Springer requirements included establishing a Programme Committee that was internationally representative and sufficiently large to perform at least three reviews per paper. In line with Springer's quality guidelines, we also had to abide to an upper limit for the acceptance rate of papers included in the CCIS proceedings. The organizing committee carefully debated and considered the benefits and drawbacks of going the Springer CCIS route. The drawbacks included the transfer of copyright to a platform that was behind a paywall, and the potential sacrifice of author inclusivity. To mitigate the drawbacks we decided to adopt a dual system of issuing both a Springer Proceedings with more rigorous quality criteria, and in keeping with IDIA's developmental spirit, a more inclusive Conference Proceedings.

We received 61 papers for review. Each paper was reviewed by at least three reviewers in a rigorous double blind peer review process. Our international Programme Committee of 66 members contributed to improve the quality of the papers by giving comprehensive and constructive reviews. Authors had to submit corrected versions of the papers before final decisions were made about the papers' acceptance. The review process concluded with 20 papers accepted for the Springer CCIS Proceedings and an additional 14 papers for the Conference Proceedings; a total of 34 papers, an overall acceptance rate of 56% and an acceptance rate of 33% for the Springer volume.

This volume contains the 14 full papers as accepted for the Conference Proceedings, as well as the titles and abstracts of the papers that appear in the Springer volume.

Thank you again to all our reviewers and authors for making this conference a success, and a great thanks to Ms Cecile Koopman and her team who so diligently managed paper submissions and Springer template compliance checks.

Kirstin Krauss

Marita Turpin

Filistea Naudé

IDIA 2018 Proceedings Chairs

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# Evaluation of the framework for sustainable mobile learning in resource-constrained environments in South Africa

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**Abstract.** Research has shown that sustaining the integration of information and communication technologies (ICTs) to support teaching and learning in government schools in resource-constrained environments in South Africa remains a challenge. Developing countries lack ICT for development (ICT4D) frameworks that are relevant to their contexts, even though it is critical to understand the context of the ICT4D project when developing such frameworks. Studies conducted to categorize and synthesize mobile learning models and frameworks, have upheld the assertion that few studies have extensively examined the dimensions that sustain mobile learning and developed frameworks for sustaining mobile learning in educational environments. The importance of sustainability of ICT4D projects has been acknowledged, however there is a lack of theoretical frameworks for guiding the sustainable implementation of developmental projects. This study is the third phase, the evaluation phase, in the development of the SFMTIS using Design Science Research (DSR) methodology. Guidelines for evaluation of utility in well-conducted DSR indicate that the utility, quality and efficacy of the artifact need to be rigorously demonstrated via well-executed evaluation methods. This article examines how the intermediate *sustainability framework for mobile technology integration in schools* (SFMTIS) artifact was evaluated in the third phase of the DSR process to develop the final SFMTIS. Face-to-face interviews were conducted with each of the seven expert reviewers who were purposively sampled and reviewers were requested to respond to a questionnaire to establish the reviewers' insights regarding the SFMTIS sustainability dimensions, and the views of the relevance, rigour, validity and utility of the framework. The research findings show that while the SFMTIS' utility was confirmed by the reviews provided by the expert reviewers, the views presented by reviewers informed the development of the final SFMTIS. Evaluation of the SFMTIS was established, aspects of the intermediate SFMTIS that required improvement were highlighted, and expert reviewers' recommendations were incorporated in the final SFMTIS.

**Keywords:** Design science research, Evaluation, Mobile technology, Tablets, Teaching, Resource-constrained schools, Sustainability.

## 1 Introduction

Sustaining the integration of information and communication technologies (ICTs) in order to support teaching and learning in government schools in resource-constrained environments in South Africa remains a challenge [10]. Research conducted by Mamba and Isabirye [6] found that developing countries lack ICT for development (ICT4D) frameworks that are relevant to their contexts, and affirms the critical need to understand the context of the ICT4D project when developing these frameworks. Few studies have extensively examined the dimensions that sustain mobile learning and developed frameworks for sustaining mobile learning in educational environments [12].

Categorization and synthesis of mobile learning models and frameworks by Hsu and Ching [2], support the assertion that prior to the development of the “Framework for sustainable mobile learning in schools” and the “Person-centred sustainable model for mobile learning”, there was no model of sustainable mobile learning in schools in the literature [12]. The latter was developed in the context of secondary education in Australia and is based on data collected at an Australian school. The application of mobile technology integration in resource-constrained environments has been widely researched, however the sustainability of mobile technology integration has received less attention.

The *sustainability framework for mobile technology integration in schools (SFMTIS)* was developed using design science research, based on research conducted in resource-constrained environments in South Africa. The SFMTIS was developed iteratively using DSR over a three year period, 2015 to 2017, in three phases starting with an initial framework, that was developed to the intermediate, and then the final SFMTIS. This study presents the third phase, the evaluation phase, in the development of the SFMTIS and the article examines how the intermediate SFMTIS artifact was evaluated in the DSR process to develop the final SFMTIS. The DSR process’ guidelines for well-conducted DSR require that the utility, quality and efficacy of the artifact be rigorously demonstrated via well-executed evaluation methods. Venable, Pries-Heje and Baskerville [15] posit that the purpose of evaluation of the designed artifact, in DSR is to establish if, the developed artifact achieves its purpose and how well, that is, its utility and efficacy towards confirming, disputing, or enhancing the design theory. In addition, evaluation enables comparison of the artifact to other designed artifacts’ ability to achieve a similar purpose, and to determine any adverse consequences, weaknesses and areas for improvement [15].

## 2 Background

In this section sustainability is discussed in section 2.1, and the development of the initial and intermediate SFMTIS outlined in sections 2.2

## 2.1 Sustainability

Sustainability of organisational innovations occurs when new ways of operating become the norm and the underlying systems and ways of working are transformed in support [11]. To be sustainable, any use of resources needs to take stock of the impact their utilisation has on the social, economic and political context of people today and in the future [16]. There are different views to considering sustainability such as economic, institutional, social and environmental, and whether the term being considered is in relation to the short, medium, or long-term view [9]. Sustainability is inextricably linked to basic questions of equity, fairness, social justice and greater access to a better quality of life [14]. Sustainable development can be considered as a dynamic process of adaptation, learning and action, rather than a destination [13].

## 2.2 Development of the initial and intermediate SFMTIS

In the first phase sustainability dimensions were synthesized to develop an *initial SFMTIS* from reviewing extant literature. Sustainability dimensions were extrapolated for the initial SFMTIS based on sustainability dimensions identified in:

- general sustainability frameworks;
- sustainability frameworks for ICT4D implementation in resource-constrained environments, and
- frameworks specifically developed for mobile learning in schools.[5].

The sustainability dimensions abstracted from the extant literature that were included in the initial SFMTIS were: Financial, political, cultural, technological, environmental, pedagogical and institutional dimensions. Mabila, Herselman and Biljon [5] provide a detailed analysis of how these sustainability dimensions were extrapolated.

In the second phase a case study was utilized to demonstrate and refine the SFMTIS developed in Phase 1, and the *intermediate SFMTIS* was developed. The perspectives of teachers and district officials regarding the integration of mobile technology in their schools were obtained, and were subsequently processed to inform the further development of the framework. The teachers were trained, and had previously participated in the Information and communication technology for rural education development (ICT4RED). The data of the teachers was supplemented by including the views of four district officials from the same school district. Phase 2 of the research was conducted six months after the implementation of the ICT4RED programme. The ICT4RED initiative is a large-scale South African government research, development and implementation initiative which was carried out over a period of three years, from 2012 to 2014, at a school district in the Eastern Cape province of South Africa. The initiative investigated ways in which ICTs can be integrated into teaching and learning in rural areas. In the ICT4RED programme projectors, screens and mobikits consisting of sets of tablets were awarded to schools based on the specific achievements of educators from the schools, using the earn as you learn concept. Educators were trained through the Professional Teacher Development program (TPD) on how to teach with technology and integrate mobile tablets in their classrooms. The deployment of tablets was supported by provision of technology hardware and software for the school infrastructure



and network connectivity, including WiFi equipment, safe-keeping and charging facilities as well as e-books, content server and related electronic resources (ICT4RED, 2015). Details on ICT4RED are available on the website: <https://ict4red.co.za/>.

The findings from the case study provided evidence which confirmed the value of the sustainability dimensions identified in literature. Financial and technical support mechanisms required for the sustainable deployment of ICTs were highlighted. The research findings indicate that communication and coordination at all levels of the education system, micro (school), meso (school circuit and district) and macro (provincial and national) is essential for ensuring sustainability. Specific issues related to institutional challenges were highlighted in the findings. This motivated the proposition of the institutional dimension to represent the structure, processes and practices at micro, meso and macro levels of the education system. The intermediate SFMTIS was refined by applying the findings of the case study to the initial framework.

Figure 1 illustrates the *intermediate SFMTIS* which comprises of:

- Structure and factors affecting sustainability of mobile technology integration.
- Factors affecting sustainability of mobile technology integration: Micro - meso interactions.
- Visual representation of sustainability framework for mobile technology integration: context of resource-constrained environments in South Africa.
- The SFMTIS for resource-constrained environments in South Africa - dimensions and aspects to consider.

The details of the *intermediate SFMTIS* components are available on <https://goo.gl/ZKe1yc>.

This article focusses on the third phase, the evaluation phase, in the development of the SFMTIS using DSR methodology, and explores how the *intermediate SFMTIS* artifact was evaluated in the third phase of the DSR process to develop the *final SFMTIS*.

In Phase 3 the intermediate framework was presented to the teachers and district officials who had formerly been interviewed during the development of the SFMTIS, as well as other experienced individuals who had been involved in the implementation of the ICT4RED initiative, for their expert evaluations. The expert reviewers' feedback was applied to refine the intermediate SFMTIS and aided in the development of the final SFMTIS. The research contributes to theory by developing the theoretically grounded, evidence-based SFMTIS, thus contributing to praxis and adding new knowledge of a focal theory that addresses sustainable mobile technology integration in schools in resource-constrained environments. The study presented in this article is the third phase, the evaluation phase, in the development of the SFMTIS. The guidelines for evaluation in well-conducted DSR, specify that the utility, quality and efficacy of the artifact must be rigorously demonstrated via well-executed evaluation methods [15]. This article examines how the intermediate SFMTIS artifact was evaluated in the third phase of the DSR process to develop the final SFMTIS.

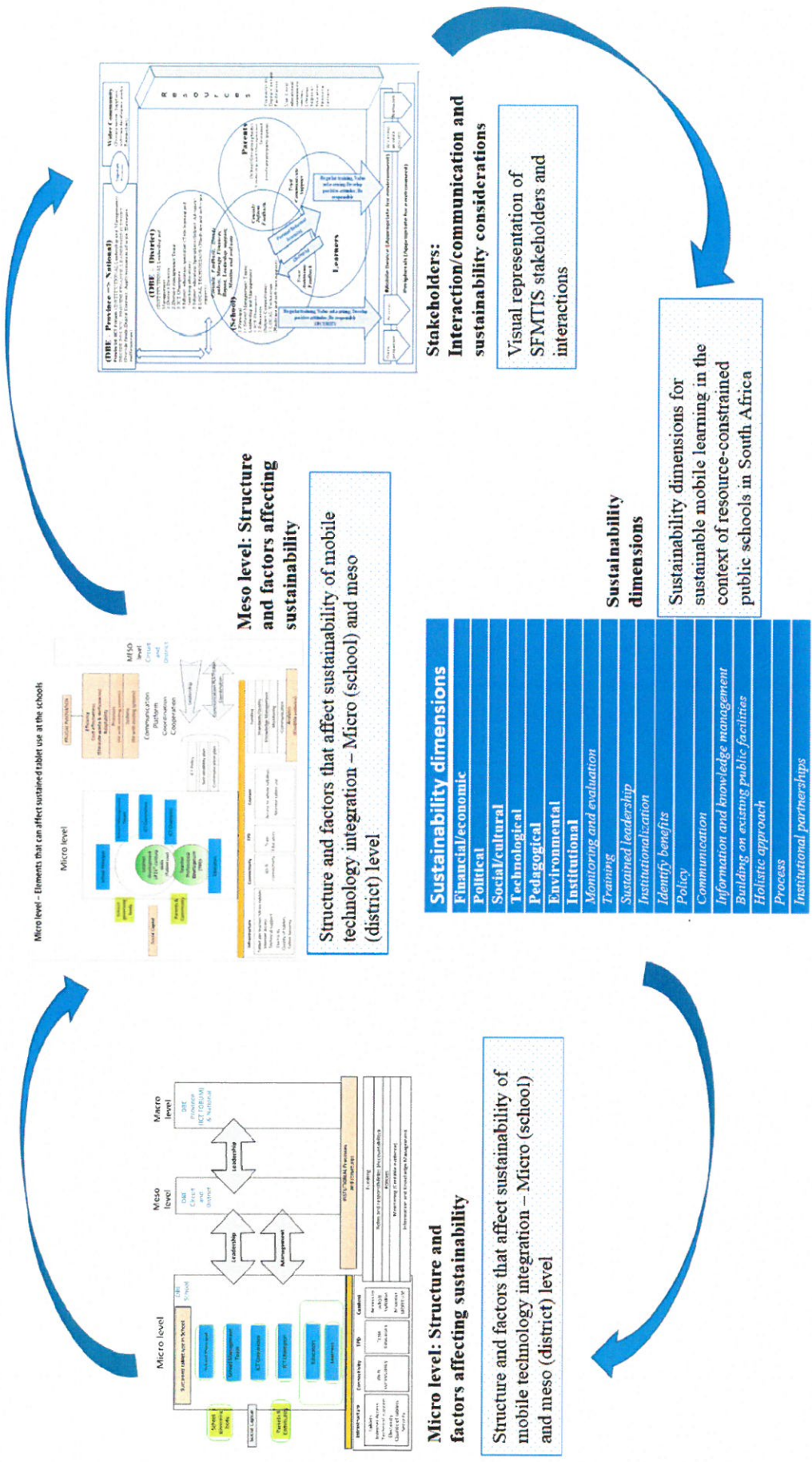


Figure 1: Intermediate SFMTIS components

### 3 Artifact evaluation in design science research

Design science research methodology was applied in the development of the SFMTIS. Figure 2 illustrates the stages undertaken iteratively in the development of the framework. The evaluation phase, highlighted in red, is the focus of the study. This is in line with the guidelines required in well-conducted design science research (DSR) that specify that the utility, quality and efficacy of the artifact must be rigorously demonstrated via well-executed evaluation methods [15].

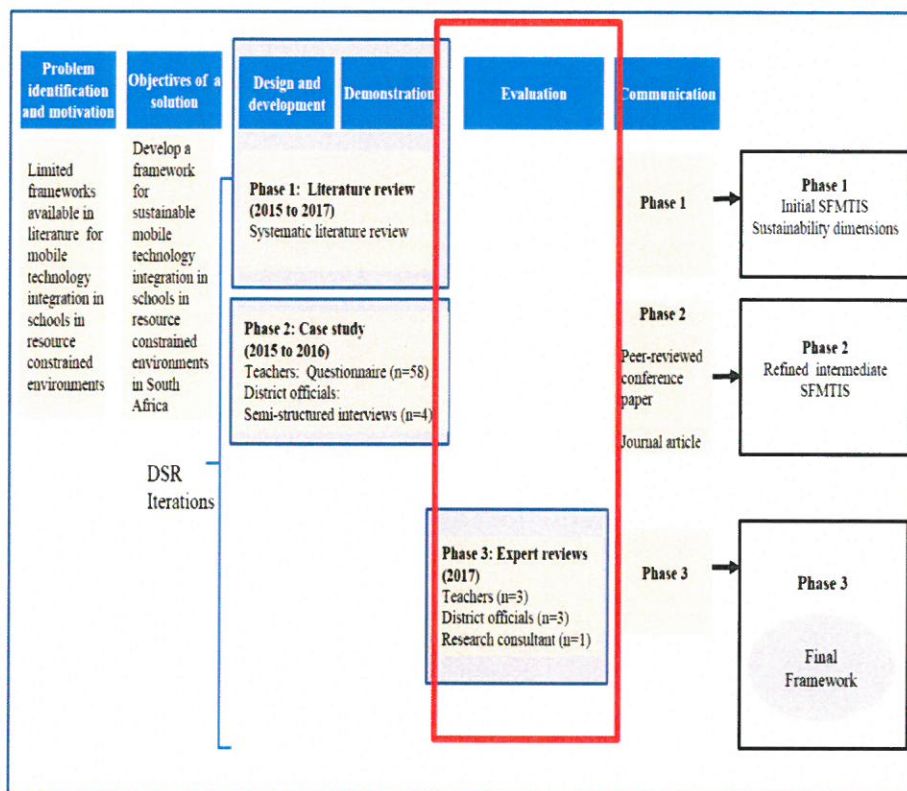


Figure 2: Phase 3 – Evaluation of SFMTIS in DSRM process (Highlighted in red) [3]

DSR creates and evaluates IT artifacts intended to solve identified organisational problems [1], and evaluating the artifact's utility in addressing the identified problems is essential, particularly where the artifact provides a type of solution, or development practices, for a particular class of user requirements [7].

The research methodology applied in the evaluation phase is outlined in Section 4 and includes the process that was followed and the type of questions that expert review-



ers answered. Findings from the expert reviews of the SFMTIS are presented and discussed in Section 5. This feedback was applied to the intermediate SFMTIS in order to develop the final SFMTIS.

## 4 Research Methodology

This section explains the data collection methods used in the evaluation phase and provides information regarding the expert reviewers who evaluated the *intermediate SFMTIS*.

### 4.1 How the evaluation of the intermediate SFMTIS was conducted

Face-to-face interviews were conducted with each of the seven expert evaluators. The expert reviewers consisted of three teachers (one principal and two school ICT Champions) and three district officials. These expert reviewers had participated in the ICT4RED initiative and had given input as to the development of the SFMTIS during the DSR iterations. An expert reviewer from the agency which implemented the ICT4RED initiative, the CSIR, was also requested to assess the framework. The selection of the experts was based on their knowledge and expertise of the environment, context and involvement in the ICT4RED initiative. Section 4.2 provides information regarding the expert reviewers' qualifications and knowhow that contributed to their selection to assess the framework.

During each face-to-face interview the intermediate SFMTIS was presented and the research process that led to the development of the SFMTIS framework was explained to the expert reviewer. Each expert reviewer was then requested to respond to a questionnaire. The questionnaire that expert reviewers responded to sought to establish the reviewers' insights regarding the SFMTIS sustainability dimensions, and the views of the relevance, rigour, validity and utility of the framework. The questionnaires utilized closed-ended questions with a Likert scale of 1 to 5, and also contained open-ended questions. The questionnaires are shown in <https://goo.gl/ZKe1yc>.

### 4.2 Information about expert reviewers

Table 1 presents information on the expert reviewers, their current positions and academic qualifications.

Expert reviewer and color ID	Current position	Highest academic qualification	Experience
Expert reviewer 1 - Teacher	Teacher at a school in Cofimvaba	BEd Honours (leadership and management)	Teacher for over 10 years and school ICT Champion
Expert reviewer 2 - Principal	Principal at a school in Cofimvaba	BEd Honours; Master's diploma (leadership and management)	32 years in basic education system

Expert reviewer 3 - Teacher	Head of department at a school in Cofimvaba	Primary teacher diploma; management and leadership programme	30 years in basic education system
Expert reviewer 4 - District	Senior subject education specialist (SES) at Cofimvaba district	BEd	Teacher (Maths & Science) 8 years; SES (9 years)
Expert reviewer 5 - District	Senior subject education specialist at Cofimvaba district	BEd Honours	Teacher (14 years); SES (10 years)
Expert reviewer 6 - District	Senior manager at Cofimvaba district	BEd	10 years in district, was also teacher in basic education system
Expert reviewer 7 - Academic	Research consultant	PhD	20 years

Expert reviewers 1 to 6 were all directly employed in the basic education system in South Africa, and had participated in ICT4RED. Reviewers 1 to 3 were based in schools within the area, and reviewers 4 to 6 at the district, while expert reviewer 7 had participated in the implementation of the ICT4RED as a research consultant at the Council for Scientific and Industrial Research (CSIR), the implementing agency of the ICT4RED initiative. Thus, all the reviewers were well positioned to provide an informed assessment of the SFMTIS.

#### 4.3 Ethical considerations

The University of South Africa's (Unisa) ethical guidelines were considered and expert reviewers' willingness to participate established after explanation of what the study entails. Individual expert reviewers signed consent forms regarding their acceptance of the request to review the intermediate SFMTIS.

## 5 Findings and discussion

Expert reviewers responded to questions relating to the artifact's utility, the rigour in the process followed when developing the framework, and its relevance. The findings are presented and discussed in the following sections.

### 5.1 Rigour in development of SFMTIS

Expert reviewers were asked whether they would consider the process followed in developing the SFMTIS to be rigorous. Expert reviewer 7 consented that the process followed in developing the SFMTIS was rigorous because: *"The design science research process that was followed provided a framework within which concepts could be grounded in theory and tested in practice. Iterative application of concepts in practice provided the opportunity for rigorous testing and the development of well-grounded*

*initiatives*". Expert reviewer 3 indicated that "*we were consulted after each cycle was finished*". 86% of the expert reviewers considered the process followed in developing the SFMTIS to be rigorous.

## 5.2 Significance of sustainability dimensions

Expert reviewers' responses to closed-ended questions in assessing the significance of the sustainability dimensions towards ensuring the sustainability of mobile technology integration in schools in resource-constrained environments are presented in the following sections.

### 5.2.1 Expert reviewers' views on the significance of sustainability dimensions to ensure the sustainability of mobile technology integration

None of the expert reviewers selected the "strongly disagree" and "disagree" options for any of the sustainability dimensions. **All the expert reviewers strongly agreed that: The economic and cultural dimensions are significant in ensuring the sustainability of mobile technology integration in resource-constrained schools in South Africa.** One of the expert reviewers noted the importance of the role of the Department of Basic Education's district offices' role in financially supporting schools. Most of the expert reviewers, 70% *strongly agreed* and 30% *agreed* that the **political, technological and pedagogical dimensions are important for sustainability of mobile technology integration.** The environmental sustainability dimension was supported by 86% of the experts who *strongly agreed* regarding the need for making plans for maintenance of tablets, replacing damaged mobile devices, planning for eventual disposal or reuse of ICT equipment. Fourteen percent of the experts *neither agreed nor disagreed*.

**All the expert reviewers strongly agreed that school security, communication, coordination and technical support provided to teachers are important considerations for sustainable mobile technology integration.** The institutional dimension examined aspects such as security, communication, coordination, technical support, teacher professional development, leadership, monitoring and evaluation, and policy. There were 86 % expert reviewers who *strongly agreed*, and 14 % *agreed* that **professional development of teachers through ICT training is important.** It is noteworthy that one of the reviewers specified that this training needs to be made available to all teachers in the circuit and not just limited to those who had participated in the ICT4RED initiative.

Seventy one percent *strongly agree*, 14 % *agree* and 14 % *neither agree nor disagree* responses for **leadership and monitoring and evaluation.** There were 57% *strongly agree*, 29% *agree*, and 14% *neither agree nor disagree* responses for policy implementation and the use of special available facilities such as e-rate for school Internet.



### 5.2.2 Expert reviewers' views on the importance of each of the sustainability dimensions

As Figure 3 illustrates, **the financial sustainability dimension was considered to be important by all the expert reviewers**. This was followed by the pedagogical and technological sustainability dimensions at 71%; institutional at 57% and the social, political and environmental dimensions at 29%. Two of the expert reviewers, 5 and 7, viewed all of the sustainability dimensions as relevant and important.

Expert reviewer 3 stated that the financial dimension is important because *"the maintenance of the tablets is a problem"*. Expert reviewers 3 and 4 also specified that security in the schools is a major problem. Levels of communication and involvement are aspects of the institutional sustainability dimension which expert reviewer 5 noted. Expert reviewer 5 indicated that the selection of appropriate technology is important.

Expert reviewer 7 stated: *"The SFMTIS tool used to score and discuss the dimensions is relevant and potentially very useful, and that the SFMTIS visual representation is useful and relevant to position the various role players"*.

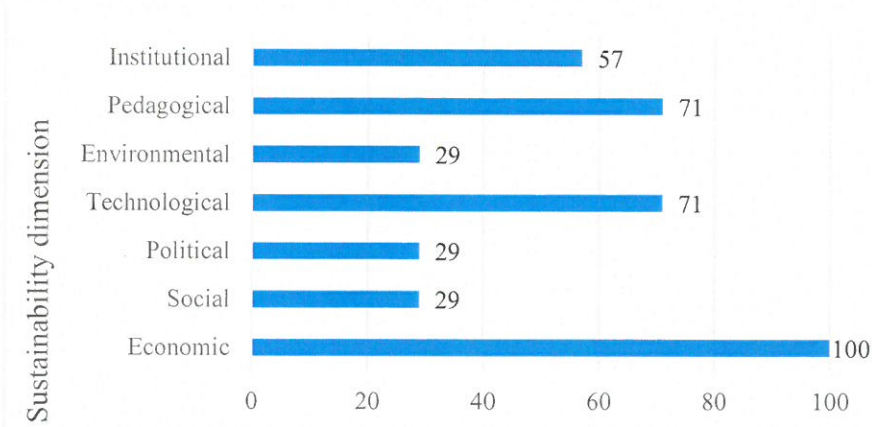


Figure 3: Percentage (%) of expert reviewers that considered the sustainability dimension as most relevant

### 5.2.3 Responses to the question: What three features of the SFMTIS would you consider as most relevant

The expert reviewers also responded to the question: What three features of the SFMTIS would you consider as most relevant? Table 2 outlines each of the expert reviewers' selection.

Table 2: Expert reviewers' top three features considered to be most relevant			
	1	2	3
Expert 1	Pedagogical	Financial	Technological
Expert 2	Pedagogical	Institutional	Financial

Expert 3	Pedagogical (“Shows if tablets are used”)	Institutional: Security	Financial (“The maintenance of the tablets is a problem”)
Expert 4	Finance	Institutional: Security (“This also shows the security which is still a problem”)	Technological (“Digital content and connectivity”)
Expert 5	All seven sustainability dimensions	Institutional: Levels of communication	Institutional: ICT policies for schools
Expert 6	Finance	Institutional: Involvement	Technological: Selection of technology
Expert 7	All the sustainability dimensions are relevant and important	The tool used to score and discuss the dimensions is relevant and potentially very useful	The SFMTIS visual representation is useful and relevant to position the various role players

The information in Table 2 indicates that pedagogical, financial, institutional and technological sustainability dimensions were prioritized by the expert reviewers.

### 5.3 Relevance

Expert reviewers responded to the questions: Does the SFMTIS address a real problem/need? and Would you consider the SFMTIS reliable enough to apply in the environment? **All the expert reviewers agreed that the SFMTIS addresses a real problem/need and that it is reliable enough to apply in the environment.** Expert reviewer 3 noted “yes it is reliable, it can assist in enhancing sustainability in our schools and also the district” and “it also shows areas that need development”. Expert 3’s view is supported by expert reviewer 5 who stated “yes (it addresses a real problem). It supports us and gives direction of continuity”. Expert reviewer 7 elaborated that “the concepts included in the framework are grounded in literature, and their application has been proven to be relevant in practice. The validity (reliability) of the framework is therefore implied”. Expert reviewer 7 also explained that “true validity would only be proven once it has been shown in a number of practical applications that sustainability has been influenced. To this end, clear indicators of sustainability would be required”. **Financial sustainability was highlighted by expert reviewers 4 and 7. Expert reviewer 4 stated:** “Yes, it (SFMTIS) is needed for sustainability although there is a problem on its application due to financial problems”. Expert reviewer 7 explained that: “The loss of investment when interventions are not sustainable is significant. In addition, engaging communities in initiatives that fail could lead to fatigue and negativity with respect to development initiatives, thus preventing future access and potential positive impacts”.

### 5.4 Ease of use and application

The questions relating to ease of use and application were: Would it be easy to use the SFMTIS? How can the SFMTIS be applied? and What effect(s) can application of the SFMTIS have? Affirmative responses were provided by expert reviewers 1, 2, 3, 4 and



5 to the question: Would it be easy to use the SFMTIS? Expert reviewer 1 stated: *“Following guidelines and applying relevant policies will ease the use of the SFMTIS”*. Expert reviewer 2 expounded: *“It would be easy because all relevant stakeholders have been interviewed, also they contributed concrete evidence and inputs”*. Expert reviewers 6 and 7 did not respond to the question regarding ease of use. In response to the question: How can the SFMTIS be applied? Expert reviewer 3 explained that: *“It would be used first at the school level, where the schools will be made aware that they need to sustain the project. The district and province, in supporting schools and also creating funding and providing workshops and technicians for the schools”*. In response to the question: How can the SFMTIS be applied? Expert reviewer 6’s stated: *“Develop it as a policy guideline when implementing new projects”*. Expert 7 responded: *“Ideally, the framework should be applied at the outset of an ICT4D implementation (planning stage), with the purpose of highlighting the important aspects that could affect sustainability, creating awareness of key issues to manage, and influencing project planning. It could also be used as a tool for checking progress of the project towards sustainability at regular intervals during implementation and re-adjusting project implementation accordingly”*.

### 5.5 What effect can application of the SFMTIS have?

Expert reviewers’ responses to the question: What effect can application of the SFMTIS have? The responses are listed in Table 3.

<b>Table 3: Expert reviewers’ responses to the question: What effect(s) can application of the SFMTIS have?</b>	
Expert reviewer 1	It can improve the quality of integration of technology in resource-constrained schools.
Expert reviewer 2	It can have a positive effect on institutions if all the features of the programme can be integrated.
Expert reviewer 3	This will assist teachers, principals and districts into knowing what their role is, and to be able to respond to the question: How do they sustain the project?
Expert reviewer 4	Yes. (1) Motivation to all stakeholders, (2) Socio-economic factors.
Expert reviewer 5	Commitment to the project by all stakeholders; informed communities on ICT.
Expert reviewer 6	-
Expert reviewer 7	It could raise awareness of key sustainability issues and influence the management and implementation of an initiative towards sustainability.

Expert reviewer 1 stated that the effect of application of the SFMTIS is that *“It can improve the quality of integration of technology in resource-constrained schools”* and, expert reviewer 7 responded that

*“It could raise awareness of key sustainability issues and influence the management and implementation of an initiative towards sustainability”*.

## 5.6 Possible improvements

The questions posed to the expert reviewers in order to establish possible improvements to the SFMTIS framework presented to them were: What three features of the SFMTIS would you consider irrelevant? and What is missing in this framework?

### What three features of the SFMTIS would you consider irrelevant?

Expert reviewers responded to the question: What three features of the SFMTIS would you consider irrelevant? Two of the expert reviewers, 3 and 4, considered all of the features of the SFMTIS to be relevant. Three of the reviewers, expert reviewers 1, 2 and 4, stated that the political dimension is irrelevant. There were two expert reviewers who considered culture to be irrelevant. Expert reviewer 5's view was that schools require the support of the department to provide finance for security and technical costs. Expert reviewer 7 suggested that two of the diagrams be integrated and improvement to another diagram by reducing the details presented.

### What is missing in this framework?

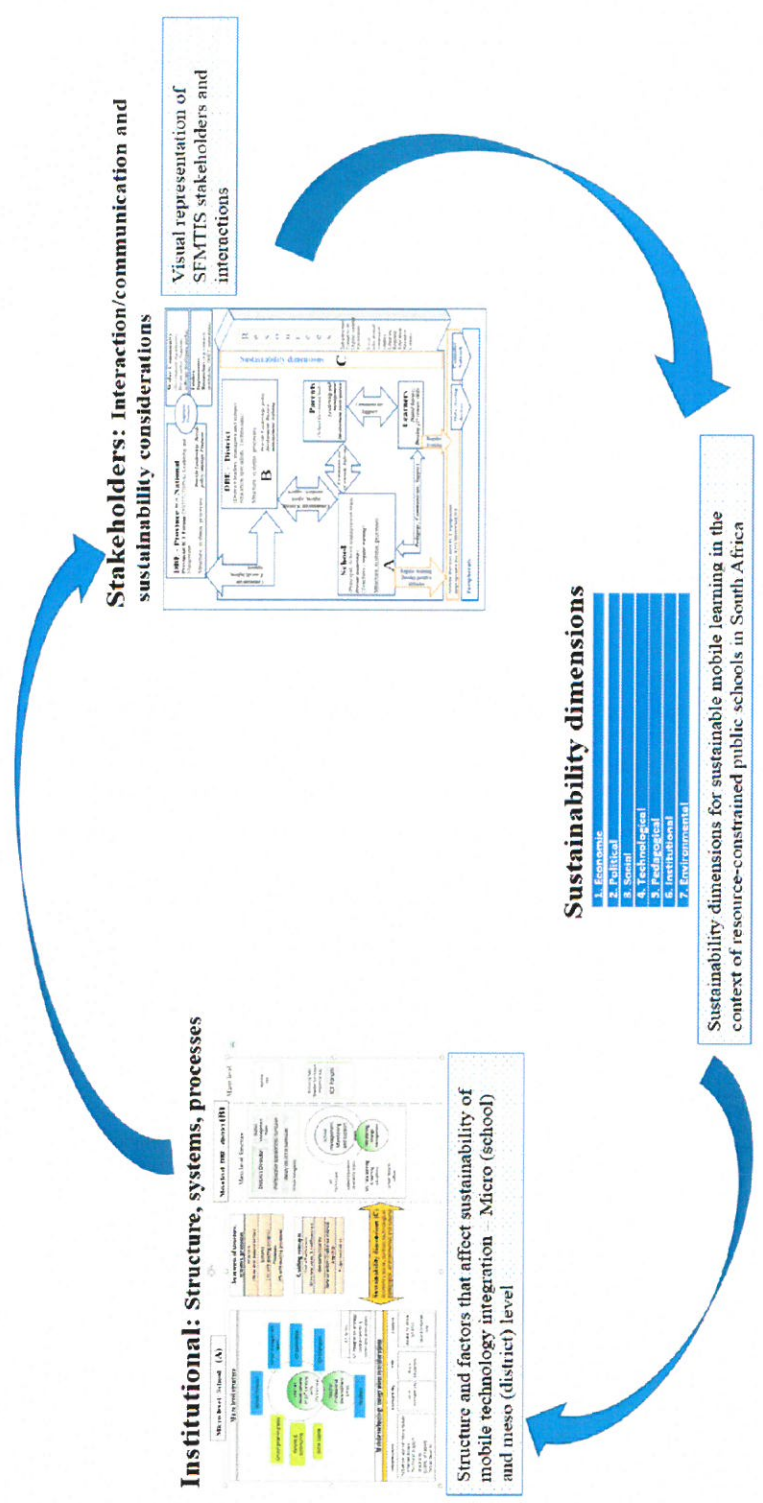
Expert reviewers 1, 2 and 3, considered the SFMTIS to be comprehensive. Expert reviewer 1 noted that *"all the relevant stakeholders are involved, as for me this is a comprehensive framework. Nothing is missing"* and expert reviewer 2 commented that *"as far as my opinion is concerned it has meaning, there is nothing that is missing"*. Expert reviewer 3 stated that *"at the moment I do not see anything missing now"*.

Additions were suggested by expert reviewers 4 and 5. Expert reviewer 4 suggested inclusion of the directive approach and expert reviewer 6 stated: *"Asking sponsors from other companies to support the project e.g. Eskom, MTN, Vodacom, etc. financially to bridge gap not done by education and schools"*. This perspective is supported by expert reviewer 7's remark that: *"The overall framework could make provision for funders, implementers, and commercial entities. These are often key to the intervention, and are not part of the education system or the other stakeholders listed in diagram"*.

Expert reviewer 7 suggested integration of the framework: *"The four different representations of the framework could be integrated into a single picture (with links between the elements, if necessary), so as to position the different ways in which the framework is implemented relative to each other, and to make the role of each clear"*. In addition, expert reviewer 7 specified the need to emphasize the strategic aspect in the institutional dimension, and explained that: *"The Institutional dimension could include a strategy element (i.e., alignment between the strategic intent at micro, meso, and macro level). In addition, the strategic intent of the implementers and funders (who could reside outside of the education system) could also be considered"*.

## 6 The final SFMTIS

The intermediate SFMTIS was refined based on consideration of the expert reviews. Expert reviewers' views applied to *intermediate SFMTIS* to develop the *final SFMTIS* shown in Figure 4:



**Figure 4: Final SFMTIS components**

(The details of the *final SFMTIS* components can be accessed at <https://goo.g/xATDEZ>)



The following were incorporated into the *final SFMTIS* based on the feedback from expert reviewers:

- Two of the diagrams representing the structure at micro and meso levels were combined into one, and the funders and implementers were given more prominence in the representation of stakeholder interactions.
- The alignment of the strategies within different levels of the department, in the institutional dimension were highlighted, and the term *data sharing devices* was utilised in the SFMTIS visual representation diagram instead of *data projector* and *printer*.

Figure 4 shows the components of the final SFMTIS:

- Visual representation of the SFMTIS stakeholders and interactions.
- Structure and factors that affect sustainability of mobile technology integration - micro (school) and meso (district) levels.
- Sustainability dimensions for sustainable mobile learning in the context of resource-constrained public schools in South Africa.
- Sustainability dimensions - practical example: Spider web.
- Sustainability dimensions - practical example: Bar chart.

The final SFMTIS incorporated the expert reviewers' recommendations, perspectives of teachers and district officials (Phase 2), and was based on the initial review of extant literature on general sustainability frameworks, sustainability frameworks for ICT4D frameworks specific to resource-constrained environments and a framework for mobile technology integration into schools.

## 7 Conclusion

The evaluation phase in the development of the final SFMTIS is examined in this article. The research expounds on how the intermediate SFMTIS artifact was evaluated through expert reviews in the DSR process to develop the final SFMTIS. The study was undertaken in a resource-constrained environment, and the SFMTIS is based on contextualized research. The evaluation of the framework is based a requirement of the DSR methodology, and the research findings highlight the value of the expert reviews in refining the artifact. The utility of the SFMTIS framework was confirmed by the reviews provided by the expert reviewers. The purpose of evaluation of the SFMTIS was to establish if the artifact developed achieved its purpose and to what extent. Evaluation established highlighted aspects of the intermediate SFMTIS that could be improved. The final SFMTIS incorporated recommendations made by the expert reviewers. The importance of the sustainability dimensions for mobile technology integration, namely: economic, political, social, technological, pedagogical, environmental and institutional sustainability was confirmed by expert reviewers' evaluation, however the levels of importance considered varied. The research was also considered by the expert reviewers to address a real need for schools and the education system to sustain mobile technology integration. Insights that emanate from experts' reviews include the importance of the economic, technological and pedagogical dimensions, and institutional sustainability aspects, such as security. The relevance of the SFMTIS was demonstrated by expert reviewers' assessment, indicating the need for frameworks such as the

SFMTIS, that can support the sustainability of mobile technology integration in resource-constrained environments. Collaboration with teachers and district officials, some of who have postgraduate degrees, is recommended for future research. The research demonstrates the value of the evaluation phase in the DSR process in the iterative development of the artifact and in providing critical assessment and feedback to aid in refining the framework.

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