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ISSUE 15, 2015
THEMATIC EDITION

INFORMATICS AND ICT FOR DEVELOPMENT

Learning Information Networking Knowledge (LINK) Centre
Faculty of Humanities
University of the Witwatersrand, Johannesburg



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The African Journal of Information and Communication (AJIC) is an academic journal published by the Learning Information Networking Knowledge (LINK) Centre, School of Literature, Language and Media (SLLM), Faculty of Humanities, University of the Witwatersrand (Wits), Johannesburg. Accredited by the South African Department of Higher Education and Training, *AJIC* is an interdisciplinary, open access journal concerned with Africa's participation in the information society and digital economy. It focuses on information and communication technology (ICT) issues, at global, regional and national levels, which have implications for developing countries in general, and for African regions and countries in particular. It encourages debate on various aspects of ICT policy, regulation, governance, strategy, and implementation, with an interest in the multiple relationships across technology, economy and society. It is intended both as a rigorous academic journal and as a practical medium to inform the continent's actors and decision-makers in government, industry, and civil society, across the diverse areas where information, communications, and new media play a role.

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EDITORIAL NOTE TO *AJIC* ISSUE 15

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The study of informatics and ICT for development (ICT4D) has progressed immensely in the past decade, 2005 to 2015. Each of these fields is broad in its own right, and they have converged to offer an even broader platform for research and investigation. From educational informatics and ICT for education (ICT4E) to data analytics, Internet presence and the Internet of Things and People, researchers can establish a rich tradition of research in this emerging field for the African continent.

There is already extensive scholarly publishing on informatics and ICT4D, charting the contours of early stage digital transformation in Africa. This issue of *The African Journal of Information and Communication (AJIC)* publishes a collection of articles developed from papers presented at the 44th Southern African Communications Lecturers Association (SACLA) Conference, held on 2 and 3 July 2015 at Open, Maboneng Precinct, Johannesburg. The theme of the conference was "Renewing ICT teaching and learning: Building on the past to create new energies". The emphasis on renewal offers an important message to academics and universities to push forward with change, in an era where change inertia has set in in many parts of the higher education environment and where a reminder is needed that, in the 21st century, change is the only constant. Digital technologies will only create value in the university experience when used for active innovation in teaching and learning, rather than passive availability. Investment in university Internet access, where most ICT spending has historically focused, offers only the foundation for educational informatics, not the digital learning experience. Educational futures require investment in the creative side of digital media use for teaching, learning and research.

Issue 15 also publishes a range of unsolicited articles relevant to this thematic area, carefully reviewed, revised and edited. These articles illustrate the breadth of the field of informatics and its importance for future development, as well as the new research problems in the fields of informatics and ICT4D. The topics of cyber-bullying and the people-centered Internet are not new, but deserve increasing attention as the challenges of ICT access and effective usage, and the issues of user protection, require more in-depth, qualitative analysis and new perspectives on the intractability of the negative consequences of Internet use and the digital divide. Research also needs to pose alternatives to such long-term negatives.

Of particular interest are the scholarly contributions from the CyberAbuja2015 conference, the International Conference on Cyberspace Governance held in Abuja from 4 to 7 November 2015, on the theme "The Imperative for National and Economic Security". The proceedings for this IEEE conference included papers on social networking, digital forensic analysis, e-voting and other topics. Organised by the Centre for Cyberspace Studies at Nasarawa State University, Keffi, Nigeria, and the local IEEE chapter, the conference provided a valuable platform for encouraging knowledge sharing amongst African academics and the postgraduate research community.

The publication of an annual thematic journal issue on informatics and ICT for development aims to draw contributions that engage with the growing research agenda and the many and varied research topics under investigation in this field, including educational and health informatics, e-government and e-governance, the history of the Internet in Africa, the emergence of an African development software sector, and more. Articles will be published online first, following which an annual journal thematic issue will be consolidated in the December of each year.

THEMATIC SECTION:
ISSUES IN EDUCATIONAL INFORMATICS:
RENEWING OUR HUMAN RESOURCES FOR THE DIGITAL ECONOMY



THEMATIC SECTION: ISSUES IN EDUCATIONAL INFORMATICS: RENEWING OUR HUMAN RESOURCES FOR THE DIGITAL ECONOMY: GUEST EDITORIAL

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For over forty years, the Southern African Computer Lecturers Association (SACLA) has provided a platform for lecturers in computer science and information systems throughout Southern Africa's higher education institutions to come together to address issues concerning the teaching and learning of ICT related topics. The 44th annual SACLA conference was held in June 2015 and was based on the theme of "renewal" entitled, *Renewing ICT teaching and learning: Building on the past to create new energies*. Seventy ICT lecturers from twelve academic institutions throughout Southern Africa convened, in the heart of Johannesburg, to report innovations in and new perspectives on what and how we teach ICT. The renewal of ICT teaching and learning within higher education is important for building the human resource capacity of the ICT sector, addressing e-skills, and thereby strengthening the role of ICT in the transformation of society and economic activity.

We are pleased to include a special section of invited papers from SACLA 2015 in this thematic issue on informatics and ICT for development. Four of the eight invited papers have been selected for inclusion. In all cases they were revised and updated, and subjected to additional rounds of peer review before final acceptance.

The first article by Chipangura and co-authors examines the factors that could affect the readiness of ICT students at a South African university to access and interact with mobile-centric services. Their work revealed that these students are ready to use mobile phones as tools for information access and interaction, but some inadequacies were observed in the way the university policies support the students' needs. They conclude with recommendations on how policies could better support students' mobile phone information access and interaction.

In the second article, Backhouse and Hughes present an analysis of students' personal information systems. They adapt the ecological model of information seeking and use it to make sense of the diversity of information sources used and students' choices in engaging with them. Their work offers insights into the information contexts and behaviours of students and argues for the importance of a flexible range of information sources to support students in the complex process of managing information for academic success.

In the third article, Van Biljon and Renaud identify ways of making the assessment of postgraduate dissertations more efficient, while retaining rigour and fairness. They examine the emerging use of visualisation as a communication facilitator and report on an investigation into the extant use and potential usefulness of visualisation in a number of dissertations, as well as supervisor expectations with respect to the use of visualisation in research reporting.

In the final article of this section, Nel and co-authors present results from a study of the software development practices used by a group of undergraduate computer science students. An experiment was conducted to determine students' perceptions on the use of process measurement data to improve their software development practices. Analysis revealed that performance-measurement data could provide students with useful information for their development practices.

Together, these articles provide valuable insight into informatics issues that are affecting students today, helping us to adapt to students' needs in our teaching, assessment and course development. This work is valuable to teaching and learning in the fields of computer science and information systems, but also has broader relevance for teaching and learning across disciplines, as ICT and educational informatics can be increasingly integrated into the learning experience.

EVALUATING MOBILE-CENTRIC READINESS OF HIGHER EDUCATION INSTITUTIONS: THE CASE OF INSTITUTIONAL POLICIES AND INFORMATION SYSTEMS STUDENTS

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ABSTRACT
Many higher education students live and operate in mobile-centric environments. The question is whether the policies of higher education institutions (HEI) are aligned with students' readiness for mobile technology information access and interaction. To investigate this question from a policy perspective, nine policies from the open and distance learning (ODL) university in South Africa were analysed for providing institutional mobile-centric support. Policy document analysis was used to evaluate five information and communication technology (ICT) polices and four teaching and learning policies. The analysis focused on how the policies support the provision of mobile infrastructure, technical support and learning resources. To investigate from the students' perspective, quantitative data was captured on Information Systems students' readiness through a survey of a total of 129 respondents from the same university. The mobile-centric readiness of students was evaluated based on factors that could affect the readiness of students in accessing and interacting with mobile-centric services. The factors investigated were infrastructure ownership, knowledge of mobile phone features and mobile phone Internet activities. The findings revealed that Information Systems students are ready to use mobile phones as tools for information access and interaction, but some inadequacies were observed in the way the policies support the students' needs. This study proposes some recommendations on how the policies could better support students' mobile phone information access and interaction.

KEYWORDS
mobile-centric services, mobile information access, mobile readiness, policies

INTRODUCTION

There is compelling evidence to show that HEIs operate in environments that are ready for mobile technology information access and interaction. The evidence is based on statistical reports produced by ICT research organisations over the past years, which show a progression in mobile technology adoption in developing countries (Kearney, 2013; Ericsson, 2015; ITU, 2015). The reports identify mobile cellular technology as the fastest growing technology that people can afford and own (Kearney, 2013). As a consequence, mobile phones have provided a platform for information access and interaction to people who were previously sidelined by lack of ownership and access to appropriate ICT technologies (Brown, Campbell & Ling, 2011). However, the benefits of mobile phone penetration have not been homogeneous across the spectrum of people's lives, in particular in education relative to business and social life. Even though mobile phones are presumed to be appropriate information access and interaction tools in pedagogy (Traxler & Vosloo, 2014), their uptake has not been fully realised. The slow growth in the integration of mobile phones in teaching and learning has been a cause of concern for the last decade, and Keegan (2005, p. 9) raised the following questions, "Why has mobile learning not yet emerged from its project status and not yet taken its place in mainstream provision? Why does it remain at the research project level and not emerge into a serious form of provision?" To date, the questions have not been sufficiently answered.

As HEIs face these challenges, literature has reported on some proposed solutions for integrating mobile phones in pedagogy. The proposed solutions are frameworks that focused on m-learning systems design (Martin et al., 2010), m-learning adaptation (Motiwalla, 2007), classification of m-learning activities (Park, 2011), adoption (Cheon, Lee, Crooks & Song, 2012) and design of m-learning activities (Muyinda, Lubega, Lynch & van der Weide, 2011). The frameworks are biased towards providing content for contextual m-learning as an extension of e-learning. The frameworks put less focus on mobile phones as tools that provide students with the ability to access and interact with information irrespective of whether the information is for learning or administration and whether the students are mobile or not. Hence, the analysed m-learning frameworks fall short of addressing the practicalities of providing mobile-centric services to students in full. In this respect, some research identified factors that restrain full integration of mobile-centric services in pedagogy as technological factors, economic factors, institutional policies and human factors (Botha, Batchelor, Traxler, De Waard, & Herselman, 2012; Isaacs Vosloo & West, 2012). This study investigated the human factors and institutional policies.

The investigation was undertaken as a case study at an open and distance learning (ODL) university in South Africa. With respect to institutional policies, this study investigated the mobile-centric readiness of two university policy groups, namely ICT, and teaching and learning policies. With respect to the students' mobile-centric readiness, this study targeted Information Systems (IS) students and investigated their mobile-centric readiness. The relatively small sample of 129 students is a limitation in terms of generalising the student--readiness findings. However, the

findings on matching student readiness with policies are generalisable. The rationale for selecting students from the discipline of information systems is that if they had problems with using the technology; this would also apply to most other students. Hence this study has two objectives, which are: (1) to evaluate the readiness of the university polices in supporting the provision of mobile-centric resources, information access, communication and infrastructure and (2) to examine the mobile-centric readiness of IS students at the university. The two objectives translate into the following research questions, (1) What is the status of the university policies in supporting the provision of mobile-centric services in teaching and learning? (2) How ready are the IS students in accessing and interacting with mobile-centric services at the university?

The paper is organised as follows: literature review analysis of frameworks for evaluating digital readiness; research methodology; data analysis results; discussion; and conclusion of the study. The following section presents a literature review of the frameworks for evaluating digital readiness.

FRAMEWORKS FOR EVALUATING DIGITAL READINESS

The digital readiness of an institution or a person in using ICT-related technologies such as mobile cellular phones is known as e-readiness (Sachs, 2000). E-readiness is defined as the degree to which a community is prepared to participate in the networked world (Sachs, 2000). In line with this definition, this study seeks to understand the concept of digital readiness by reviewing e-readiness frameworks in the context of HEIs. The frameworks reviewed in this study focus on evaluating e-learning readiness. For the purpose of this study e-learning is considered an umbrella term that covers the provision of learning through electronic media such as computers and mobile phones.

This study reviewed four e-readiness frameworks. They are an eclectic model for assessing e-learning readiness in the Iranian universities (Darab & Montazer, 2011), a readiness combination model for acceptance of e-learning (Borotis & Poulymenakou, 2004), the Machado model (Machado, 2007) and the Haney model (Haney, 2002). The consensus among the models for evaluating e-readiness is that when introducing e-learning at an institution, all the stakeholders that would be involved in the project have to be assessed for e-readiness (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007). The stakeholders include administrative managers, academics, and students. Common dimensions among all the proposed models for evaluating e-readiness were infrastructure, finance, human resources and course content. The frameworks do not directly inform the readiness of students in using mobile-centric services in pedagogy, but there are some common dimensions, which could be summarised as follows:

- Infrastructure readiness assessment focuses on evaluating whether existing infrastructure could sustain the new intervention. If the existing infrastructure cannot provide or sustain the services of a new intervention, the institution would be expected to provide the required infrastructure. This dimension is important in this study because students would only use mobile phones as information access and interaction tools if they own or have access to the devices.
- Human resources readiness focuses on evaluating the incumbents in terms of motivations, attitudes, resistance and skills required in providing e-learning. With respect to human resources readiness, Machado (2007) recommended that prior to the implementation of e-learning services, it is important to understand the administrators' vision, their abilities in implementing policies and strategies that inform e-learning. The policies and strategies would be expected to capacitate other stakeholders in terms of motivation and training.

The readiness combination model for the acceptance of e-learning (Borotis & Poulymenakou, 2004) has a unique dimension, which is the business dimension. Business readiness is measured by assessing institutional goals, needs, motivators, resources and constraints with respect to e-learning. Two of the models, the eclectic model for assessing e-learning readiness in the Iranian universities (Darab & Montazer, 2011) and the readiness combination model for acceptance of e-learning (Borotis & Poulymenakou, 2004) suggested that e-readiness evaluation could be based on institutional culture. The cultural aspect is important in this study because it is essential to understand the mobile-centric culture of students. The mobile-centric culture of students is a characteristic of the generation Y culture (Noble, Haytko, & Phillips, 2009). The generation Y people have been described as people born with technology (Prensky, 2001), have a high aptitude for technology use, propensity for establishing social networking groups and quickly turn to Internet for information access (Ling & Horst, 2011).

The technological culture and infrastructure ownership readiness of students is the basis of mobile-centric readiness evaluation in this study. Hence, the research question posed is, "How ready are the Information Systems students in accessing and interacting with mobile-centric services at the university?"

Apart from the students' technological culture and infrastructure ownership, the usage of mobile phones as pedagogic tools also depends on the readiness of institutional policies. The readiness of institutional policies in supporting the provision and utilisation of mobile-centric services has been identified as a critical factor in pedagogy (Traxler & Vosloo, 2014; Vosloo, 2012). Vosloo (2012) observed that ICT policies in pedagogy were obsolete and were failing to guide full integration of mobile-centric services at HEIs. This is in line with Czerniewicz and Ngugi (2007), who found South African ICT educational policies fragmented and lacked strategy for supporting the use of ICT in pedagogy. In this respect, Vosloo (2012) found South African ICT educational polices to mostly govern the provision of infrastructure, but weak in terms of curriculum design and assessment. Furthermore, Traxler and Vosloo (2014) argued that the benefits of mobile-centric services would not be realised in pedagogy if they are not supported by policy. UNESCO identifies

this as a problem that needs urgent attention (UNESCO, 2011). In an effort to find solutions, UNESCO has organised at least three Mobile Learning Week symposiums since 2011 to discuss the issue of m-learning policy (UNESCO, 2011; UNESCO, 2013; UNESCO, 2014). At present the outcome of the Mobile Learning Week symposium is the publication of guidelines that inform the design of policies that regulate the use of mobile technology in education (Kraut, 2013). This highlights the importance of policy as a critical factor that supports the provision of mobile-centric services in pedagogy. Hence one of the research questions posed in this study is, "What is the status of the university policies in supporting the provision of mobile-centric services in teaching and learning?"

RESEARCH METHODOLOGY

This study evaluated the mobile-centric readiness of IS students as well as institutional policies in supporting the provision of mobile-centric services. The research was undertaken as a case study at an ODL university in South Africa. The research questions are:

- What is the status of the university policies in supporting the provision of mobile-centric services in pedagogy?
- How ready are the IS students in accessing and interacting with mobile-centric services at the university?

The study employed two data collection instruments to collect data - a policy document analysis and a quantitative student survey. The following section presents research context, design of data collection instruments and samples.

RESEARCH CONTEXT

The University of South Africa (UNISA) is 140 years old. UNISA is the largest ODL university in South Africa with a student population of over 350,000. The majority of the students are from African countries. The university operates in an environment which is technologically ready to provide mobile-centric services due to high levels of mobile phone penetration. According to ITU (2015), the South African mobile phone penetration has surpassed 100%, which implies that majority of the people in the country have access to a mobile device. Hence, this provides an environment that has the potential to be conducive to the provision of mobile-centric services.

POLICY DOCUMENT ANALYSIS

The design of the policy document analysis protocol employed in this study was informed by the e-readiness frameworks discussed in the study. Based on the frameworks, the factors adopted for evaluating e-readiness are infrastructure readiness, technical expertise readiness, and resources readiness. In addition to these parameters, the policy document analysis protocol also analysed how the policies support mobile phone communication and interaction (Kraut, 2013). Table 1 presents the document analysis protocol of this study.

TABLE 1: DOCUMENT ANALYSIS PROTOCOL

Name of policy	What is the name of the policy?
Purpose	What is the purpose of the policy?
Integration of mobile technology	How does the policy address the integration of mobile technology in pedagogy?
Providing technical training	Which student development intervention does the university have in place?
Providing mobile phone infrastructure	How is the infrastructure provided and supported by the university?
Providing access to mobile phone resources	What are the guidelines for providing students with access to mobile phone resources?
Supporting student communication and interaction	What are the guidelines for lecturer to student communication and interactions?

The study employed purposeful sampling to select nine polices for analysis; four were Teaching and Learning policies, and five were ICT policies. The policies are available on the university website and are accessible to all members of the university (UNISA 2015). The Teaching and Learning policies covered the following areas: *Tuition; Curriculum; Open distance learning (ODL);* and *Prescribed books and journal articles.* The ICT policies covered: *ICT mobile device; Telephone and cell phone; Sending of SMS and emails to students, Internet; Electronic communication and web management;* and *Broadband agreements.*

Policy document analysis was based on the Framework Analysis method (Ritchie & Spencer, 1994). The advantage of the Framework Analysis method is that it is inductive and has systematic stages of analysing data. The stages are familiarising, identifying a thematic framework, indexing, charting, mapping and interpretation.

STUDENT SURVEY

A quantitative survey was used to collect data from students. Purposeful sampling was used to enroll the participants and 129 students completed the questionnaire. The students were third-year IS students registered for a database course in the School of Computing at the university. The gender ratios of the students were 32% female and 68% male.

The design of the questionnaire was informed by the findings of the literature review analysis. The questionnaire had three sections, all with close-ended questions. Table 2 presents the survey questions. The first question measured

the mobile-centric readiness of students based on ICT infrastructure ownership. A list of devices was provided to students that included mobile phone, laptop, printer, desktop computer and iPad or tablet PC. The second question measured the mobile-centric readiness of students based on their knowledge of mobile phone features. A list of fifteen mobile phone features was provided to students and included SMS, Internet access, camera, video player, email and apps download, to mention just a few. The third question measured the mobile-centric readiness of students based on the Internet activities that they engage in through a mobile phone. A list of 16 activities was provided that included search Internet for facts, access health information, and watch videos online, to mention just a few.

TABLE 2: STUDENT SURVEY QUESTIONS

Question	Response
1. Which of the following electronic communication devices do you own? (The devices were then listed, e.g., Mobile phone, laptop ...)	Yes ☐ No ☐
2. Which of the following features are available on your mobile phone? (The features were then listed, e.g., SMS, Internet, camera …)	Yes ☐ No ☐ I do not know ☐
3. As part of your normal routine, to what extent do you engage in the following activities on your mobile phone? (The activities were then listed, e.g., Search Internet for facts, watch videos …)	Not applicable ☐ Never Seldom ☐ Often Very often ☐

After collecting the data from the survey, it was cleaned in preparation for analysis. The questionnaire captured both nominal and ordinal data. Descriptive statistics were employed to analyse both the nominal and ordinal data in order to give a summary of how the group responded to each of the survey questions. Factor analysis was employed to uncover trends that were not visible from descriptive analysis.

DATA ANALYSIS RESULTS

The data analysis results are divided into two sections - policy document analysis results and student survey results.

POLICY DOCUMENT ANALYSIS RESULTS

This section reports on the results of the first research question, namely "What is the status of the university policies in supporting the provision of mobile-centric services in teaching and learning?" The results are discussed under the following themes: integrating mobile technology; providing technical training; providing mobile phone infrastructure; supporting student mobile phone communication; and interacting with and providing access to mobile phone resources.

INTEGRATING MOBILE PHONE TECHNOLOGY

The policies were updated to govern the use of mobile technologies at the university. The university introduced two new ICT policies and revised two ICT policies and three teaching and learning policies to reflect the dynamics and the evolution of mobile technology in teaching and learning as detailed in Table 3.

TABLE 3: ANALYSED POLICIES

Policy name	Approved data	Revision date
ICT policies		
Policy on sending SMS and emails to students (new)	04-10-2011	23-11-2012
ICT Mobile device policy (new)	20-09-2013	
Telephone and cell phone policy (revised)	29-07-2005	22-11-2013
ICT policy on broadband agreements (revised)	26-06-2008	22-11-2013
Teaching and learning policies		
Tuition policy (revised)	29-07-2005	05-04-2013
Prescribed books, readers, and journal articles policy (revised)	30-09-2005	20-09-2013
Curriculum policy (revised)	19-11-2010	23-11-2012

The purpose of the teaching and learning policies includes providing principles that guide pedagogy, guidelines for prescribing study material, and curriculum design. The policies seem to address the issue of providing mobile technology services under the banner of integrating innovative technology in pedagogy. Furthermore, the ICT-related policies provide general guidance on the provision of ICT infrastructure, security, ethical behaviour, communication, and interaction on the university network. Therefore the policies implicitly support the provision of mobile-centric services in teaching and learning.

PROVIDING TECHNICAL TRAINING

The policies provide training for empowering lecturers with digital technical skills. Three policies – *Tuition, Open Distance Learning* and *Curriculum* – addressed the issue of lecturer training with respect to integrating technology.

Two of the policies, namely *Tuition* and *Open And Distance Learning*, addressed the issue of lecturer training in general without specifying the type of training. In this respect, the *Curriculum* policy explicitly stated that employees would receive adequate training that could enable them to develop, implement and experience e-learning or m-learning. Therefore, the policy explicitly supports training for lecturers but there is no mention of student training.

PROVIDING MOBILE PHONE INFRASTRUCTURE

Three ICT policies addressed the provision of mobile infrastructure in terms of mobile phone ownership, access to network services and cost of broadband. The policies are: *ICT Mobile Device*;, *Telephone and Cell Phone*;, and *ICT Policy on Broadband Agreements*. The policies cover aspects of how university employees and students could own and use mobile devices on the university network. Ownership and use of mobile devices on the university network is granted under the following conditions: Bring Your Own Devices (BYOD), purchase a mobile device through a research funding grant, or own a university funded mobile device. The policies stipulate that device owners are responsible for the physical security of their devices and that access to the university network is granted under security conditions.

SUPPORTING STUDENT MOBILE PHONE COMMUNICATION AND INTERACTION

Mobile communication and interaction are regulated by both the Teaching and Learning polices and the ICT policies. The teaching and learning policies are broad, while the ICT polices are more specific. The two ICT polices that focus on aspects of mobile communication and interactions are: *Policy on Sending SMS and Email*; and *Internet, Electronic Communication, and Web Management Policy*. The policies provide code of conduct of how lecturers could communicate and interact with students. The code of conduct covers aspects of ethics, quality of communication, and providing students with equitable access to communication and interaction resources.

PROVIDING ACCESS TO MOBILE PHONE RESOURCES

The university supports the design of content for mobile access in general without providing guidelines on how to implement that. The teaching and learning policies address the issue in a general way, encompassing all types of technologies, and do not specifically refer to mobile technology. In particular, the *Open and Distance Learning Policy* recommends that lecturers design learning content that is accessible on the web and takes advantage of interactive technologies. The ICT policy that addresses the issue of designing content for online access is the *Internet, Electronic Communication and Web Management Policy*. The policy is broad and stipulates that lecturers should design quality online course material for students' access. The policy cautions lecturers from distributing learning content intended for registered students on social media platforms.

STUDENT SURVEY RESULTS

The student survey results are discussed under the following categories: ICT infrastructure ownership, knowledge of mobile phone functionality, and mobile phone Internet activities.

ICT INFRASTRUCTURE OWNERSHIP

Mobile phone ownership was compared to other devices owned by the IS students. Students were asked a multiple-choice question that required them to choose from a list the ICT devices that they own, by a "yes" or a "no". The question reads, "Which of the following electronic communication devices do you own?" The results established that all the students (100%) owned a mobile phone. The second ranked device owned by the students was a laptop (81%), followed by a printer (54%), a desktop computer (53%) and an iPad/tablet (18.8%). Hence the results confirm that in terms of infrastructure ownership, most students are ready to use mobile phones as information access and interaction tools.

KNOWLEDGE OF MOBILE PHONE FEATURES

IS students were surveyed to see if they know the functionality of their mobile phones. They were asked to identify features on their mobile phones from a list of features with a "yes", "no" or "I do not know". The question reads, "Which of the following features are available on your mobile phone?" Table 4 presents the descriptive statistical analysis results. The results revealed that most students managed to identify most features on their mobile phones but a few failed. Some students could not identify the following features: apps download (8%), voice recorder (3%), or document reader (9%). Some students indicated that their mobile phones had no features such as Internet access (3%), emails (2%), camera (3%), video player (3%) or apps download (5%). Absence of such features affects the readiness of students in using mobile phones as information access tools.

TABLE 4: MOBILE PHONE FUNCTIONALITY

Which of the following features are available on your mobile phone?	Do not know	No	Yes
SMS	0.0%	0.0%	100.0%
Internet access	0.0%	3.1%	96.9%
Camera	0.0%	3.1%	96.9%
Video player	0.0%	3.1%	96.9%
Calendar	0.0%	0.0%	100.0%
Emails	0.8%	2.3%	96.9%
MP3 player	2.3%	3.1%	94.6%
Voice recorder	3.1%	4.7%	92.2%
Games	0.0%	3.9%	96.1%
Document reader	8.5%	9.3%	82.2%
Twitter	7.0%	10.9%	82.2%
Clock	0.0%	0.0%	100.0%
Maps	8.5%	9.3%	82.2%
Instant Messenger	11.6%	6.2%	82.2%
Apps download	7.8%	5.4%	86.8%

MOBILE PHONE INTERNET ACTIVITIES

IS students were asked to reveal Internet activities that they usually perform on their mobile phones. The question reads, "As part of your normal routine, to what extent do you engage in the following activities on your mobile phone?" Table 5 presents the descriptive data analysis results. The results show that there are certain activities that the students tended to perform more often than others. For example, checking email (83%), replying to emails (73%) or viewing pictures (75%). On the other hand, students rarely download videos (37%) and songs (32%) or watch online videos (24%). Further investigation using factor analysis was undertaken to see if there were some latent variables within the dataset and categorise the activities.

TABLE 5: GENERAL MOBILE PHONE ACTIVITIES

"As part of your normal routine, to what extent do you engage in the following activities on your mobile phone?"	N/A	Never	Seldom	Often	Very often
Search Internet for news	4%	8%	20%	22%	46%
Search Internet for facts	6%	19%	25%	19%	31%
Search Internet for health information	5%	15%	29%	25%	26%
Access sport results	6%	20%	26%	21%	26%
Search for movies or films	5%	32%	37%	12%	13%
Watch a video online	4%	24%	40%	14%	17%
Download videos	5%	37%	26%	16%	16%
Access and update social networking sites	4%	8%	21%	27%	40%
Check emails	4%	2%	12%	19%	64%
Reply to emails	4%	3%	19%	19%	54%
View pictures on a mobile phone	4%	5%	16%	37%	38%
Download songs	4%	32%	32%	12%	19%
Take pictures	4%	5%	15%	31%	45%
Download documents	4%	16%	22%	23%	35%
Surf the web	5%	26%	25%	21%	22%
Chat with friends	3%	9%	13%	24%	50%

Factor analysis identified three categories of student mobile phone activities and they are presented in Table 6. The three categories of factors were identified as information gathering, communication and social connection activities.

The factors were determined based on the eigenvalues, cumulative percentage of variance, and the Scree plots. The factor analysis extraction method used was the Maximum Likelihood and the rotation method was Varimax. An initial analysis

to get the eigenvalues for each factor extracted three factors with Kaiser's criterion of greater or equal to 1. The three factors had eigenvalues of 7.3205 (45.753%), 1.4975 (9.359%) and 1.0974 (6.842%). The three factors contributed a total variance of 61.95%. The three factors were returned for data analysis and the items with factor loading greater than 0.4 were considered to be valid. Reliability analysis was applied to each of the factors identified during Factor analysis. The results show that all the factors were reliable, with high scores of Cronbach's Alpha coefficients above 0.7.

TABLE 6: ROTATED FACTOR LOADINGS OF MOBILE PHONE ACTIVITIES

Item	Factor 1 (Information gathering activities)	Factor 2 (Communication activities)	Factor 3 (Social connection activities)
1. Search Internet for news	**0.59**	0.42	0.23
2. Search Internet for facts	**0.56**	0.19	0.15
3. Search Internet for health information	**0.59**	0.34	0.25
4. Access sports results	**0.50**	0.27	0.22
5. Search for movies or films	**0.60**	0.17	0.04
6. Watch a video online	**0.65**	0.09	0.34
7. Download videos	**0.75**	0.13	0.12
8. Access and update social networking sites	0.26	0.31	**0.46**
9. Check emails	0.23	**0.84**	0.25
10. Reply emails	0.28	**0.81**	0.24
11. View pictures on a mobile phone	0.26	0.30	**0.66**
12. Download songs	0.70	0.19	0.23
13. Take pictures	0.12	0.09	**0.78**
14. Download documents	0.53	0.52	0.24
15. Surf the web	0.55	0.26	0.34
16. Chat with friends	0.25	0.38	**0.45**
Eigenvalues	7.321	1.498	1.097
% Variance	45.75%	9.35%	6.84%
Cronbach's Alpha	0.90	0.90	0.84

DISCUSSION

This study established that all the Information Systems students surveyed owned a mobile phone and seemed to be ready to use mobile phones as information access and interaction tools. Matching students' mobile phone ownership with the contents of policies, the policies did not address the issues of providing students with mobile phone devices. The policies encourage students to bring their own devices (BYOD) and use them to access the university network. The implication of the BYOD is that students have a variety of mobile phones, with some having better functionality than others; for example, smart phones compared to feature phones. As established in this study, some students indicated that their mobile phones had no multimedia capabilities, for example, features such as apps download, emails, video player and document reader. Such mobile devices would be difficult to use as information access and interaction tools in learning, hence there is risk of introducing information access divide based on mobile phone functionality. Even though BYOD has some advantages, institutional policies need to recognise that students from lower income families may need financial assistance in procuring mobile phones with multimedia capabilities.

Students can only use their mobile phones as information access and interaction tools if they are knowledgeable about the features of their devices. The IS student survey results established that even though the students managed to identify most features on their mobile phones, a few students failed to do so. The students failed to identify features, such as a voice recorder, Twitter, Skype, apps download or maps. Students who were not aware of all the features on their mobile phones were assumed not to be fully ready to use their mobile phones. Considering that these were IS students, it can be concluded that most other students could face similar challenges. Therefore, technical support needs to be available on how to fully use the necessary functions of the mobile phones. With regard to student training, the results of policy analysis established that the policies made no reference to providing students with technical training on using the mobile phones in the HEI environment. While the policies did not refer to student training in using mobile phones they supported professional development of lecturers with respect to integrating technology in teaching and learning. This study recommends that institutional policies include mobile training for students.

This study confirmed that the IS students are ready to use their mobile phones for the following activities: information gathering, communication and social connection.

This study considered information gathering as a characteristic of readiness in using mobile phones as an information access and interaction tool. The results confirmed that the IS students have some mobile phone information-gathering skills, for example, searching the Internet. This suggests that if the university provides students with mobile phone services that enable them to gather information, the students should be ready to use such services. Matching the students' information-gathering activities with the institutional policy support, the results of policy analysis established that lecturers are required to design content that is accessible on the web and utilises interactive technologies. This finding confirms that the institutional policies are ready to provide students with mobile-centric information resources.

The communication activities that the students were familiar with included SMS texting, telephone calling, chatting or checking email. The results confirm that the students have some mobile phone communication experience, which implies that they are ready to communicate with other students and their lecturers. Matching communication readiness of students with institutional policy support, policy document analysis established that the university supports mobile phone communication with students. Mobile phone communication is supported by the policies under the pretext of providing equitable communication to students. The university has specific policies that govern communication through telephone, SMS, email and Voice over Internet Protocol (VoIP) services such as Skype. The policies also enforce aspects of ethics and code of conduct when communicating with students. The results confirm that institutional policies are ready to govern mobile communication at the university.

The social connection activities that the students were familiar with included visiting social networking sites, chatting with friends, uploading and viewing pictures. The experience gained when interacting on social media platforms is important in that it improves students' communication and interaction, sharing of content and knowledge, collaboration and virtual presence. Additionally, technologies that are available on social media platforms could enable students to have synchronous peer tutoring and group work. Therefore, the findings of this study provide evidence that the IS students are ready to use their mobile phones for information access, interaction and sharing resources. Matching social media readiness of students with institutional policies support, the results established that the university has some guidelines on how social media should be used in pedagogy. The policies encourage academic and non-academic departments to utilise social media for marketing purposes only. Academic departments are discouraged from distributing copyrighted content on social media as only registered students should have that access privilege. Hence the results confirm that the institutional policies are adequate to govern the utilisation of social media in pedagogy.

The relatively small number of 129 participants is a limitation to the generalisation of this study. Furthermore, the students were all third-year IS students from an ODL university in South Africa. The technical aptitude and mobile devices owned by such students could be different from the rest of the student population at the university. However, as noted, the selection means that the ICT challenges experienced by these students would likely apply to all other students. The policies analysed in this study were from the same ODL university. However, the findings on matching student readiness with policies are generalisable. Despite the identified limitations, the study contributed to the understanding of mobile-centric readiness of students and institutional policies.

CONCLUSION

This study investigated mobile-centric readiness of a HEI by considering institutional policy support against the case of IS students' readiness at an ODL university in South Africa. Any policy needs to be evaluated in context and that is the value of having considered the policies against the students' mobile-centric readiness. The contribution of the paper lies in identifying the potential mismatches between institutional policies for supporting students in using mobile-centric services and student readiness.

The findings indicate that students' mobile-centric readiness is affected by device ownership, features present on the device and knowledge of using the features. Despite being generally supportive of mobile-centric access, some inadequacies were observed in how institutional policies support the provision of mobile-centric services at the university. For example, when a student does not have a mobile phone or a student has a basic phone with minimum functionality, the BYOD policy has the potential for information access discrimination. Furthermore, the policies do not address the issue of training students on how to use mobile phones as information access tools. Without the required knowledge of mobile phone features, students will not be able to access and interact with the HEI resources. Based on the findings of this study, we recommend that HEIs provide policies supported by best practice frameworks that guide the provision of mobile-centric services. The policies are recommended to at least address issues of infrastructure, resources, mobile technology integration, technical training and support for using mobile-centric information and communication technology.

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AN ECOLOGICAL MODEL TO UNDERSTAND THE VARIETY IN UNDERGRADUATE STUDENTS' PERSONAL INFORMATION SYSTEMS

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ABSTRACT
A first-year undergraduate course in Information Systems in a South African university includes an opportunity for students to reflect on their own use of information and personal information systems. Their reflections provide data about the technologies and tools that they use to find and manage everyday life information, as well as academic information, and about the sources of information they draw on. This paper analyses data collected over three years and reports on the dominant technologies and information sources that students use. We then adapt the ecological model of information seeking and use developed by Williamson (1998) to make sense of the diversity of information sources and students' choices in engaging with them. The results show that students rely to a very small degree on traditional university information sources. The study offers insights into the information contexts and behaviour of students and argues for the importance of a flexible range of information sources to support students in the complex process of managing information for academic success. The results will be of interest to those involved in designing and delivering undergraduate programmes, as well as those providing information services and infrastructures.

KEYWORDS
personal information system, information behaviour, undergraduate students, information technology, information seeking, information sources, personal informatics

INTRODUCTION

"Fundamentals of Information Systems" is a one-semester course offered in the first year of the Bachelor of Commerce (B.Com) degree at the University of the Witwatersrand, South Africa. It is a compulsory course for all B.Com students and an elective course for students from other faculties, with the aim of teaching them enough to be an "educated end user" of information systems, while gaining a basic understanding of Information Systems applied to the individual, organisational and societal levels.

During 2013, the course underwent a major change in approach to introduce more of a systems focus and to move away from the traditional presentation of information systems to novice learners, which tends to build up from hardware components to networking, databases and software, to business concerns (Stair & Reynolds, 2013). As this course is focused on students who will go into business, the public sector or non-profits in a range of capacities, our goal was to produce users of information systems who will understand the role of information systems in organisations, be familiar with the key elements of an information system, and be able to engage constructively with IS professionals in selecting, designing or implementing information systems in their workplaces. In addition to this organisational focus, the course also encourages students to think about the effects of technology on the individual and on society, thus addressing the three levels mentioned above.

In order to manage the variety and volume of information associated with university study, students need to develop complex personal information systems that incorporate both physical and digital elements (Mizrachi & Bates, 2013). Thus a secondary aim of the course is to address the very different levels of exposure to information technology and information sources that students have when arriving at university and to ensure that those who are not experienced in using these tools quickly learn enough to be able to make use of them. To this end, the course includes an exploration of personal information systems, during which students are introduced to and encouraged to share information about technologies and information sources that might be of use to them. Students are therefore made aware that they have a personal information system and are also encouraged to think critically about its composition and effectiveness.

As university lecturers, we are interested in the information behaviour of students – how they source, store, manage and use information – to inform our teaching. We teach students who are "millennials", born between 1979 and 1995 (Murray, 1997) and are regarded as skilled in and accepting of information technologies. However, these students' information behaviour has been informed by ready access to information selected chiefly for its social and entertainment value and they are arguably ill-equipped to access and evaluate academic information, which activity may require perseverance and judgement (Becker, 2012). In particular, students newly arrived at university need to be able to access knowledge that they do not yet know that they lack and a personal information system that facilitates this would benefit them.

From student assignments conducted during the course, we have gathered insights into what information technologies and information behaviours students use. This study replicates other studies that have looked at the sources and information-seeking strategies of students (Ajiboye & Tella, 2007; Chung & Yoon, 2015; Given, 2002;

Lee, Paik & Joo, 2012; Ossai-Onah, 2013; Sin & Kim, 2013), but does so using the idea of a personal information system, whereas other studies looked at information behaviour from the perspective of Information Science. It also adds to a limited number of studies that examine the devices that students use (Chung & Yoon, 2015). By examining data over three years, we are able to observe trends in the use of devices. In addition, observing that past research into student information behaviour is frequently descriptive and lacks theoretical framing, this paper examines a range of theories of information behaviour and proposes an ecological model of students' information behaviour, which has important implications for practice.

PERSONAL INFORMATION SYSTEMS

Research into personal information management began in the 1960s, with studies that focused on how academics and researchers organised their information gathering and storing activities (Parker & Paisley, 1966; Soper, 1976). The term *personal information system* was used in the 1980s to describe the sources of information and the information gathering practices of individuals, and particularly managers, following Mintzberg's study of the nature of managerial work and how managers made use of information to inform their decision-making (Mintzberg, 1973). Around the same time, studies emerged that examined personal information management in computerised contexts (Burton, 1985; El Sawy, 1985).

More recently, the term personal information system (or personal informatics) has been used to mean an information system that stores personal information, for example about one's health and fitness or personal finances, that is used by individuals for self-improvement (for example Kamal, Fels & Ho, 2010; Li, Medynskiy, Froehlich & Larsen, 2012). The term personal information system in the former sense has since been largely replaced by the term *information behaviour*. In library and information science the term information system was replaced by the term *information-seeking behaviour* because "behaviour is observable" (Wilson, 2005, p. 34) and later by the term *information behaviour* to encompass the behaviours associated with the storage, management and use of information.

In the "Fundamentals of Information Systems" course, we introduce students to the idea of personal information systems in both senses. We prefer to use the term personal information system to describe students' information behaviour, because we want students to draw analogies to business information systems, recognising that people, processes, places and technologies form part of both. We also make them aware of the second use of the term personal information systems. In a sense though, a student's personal information system (information behaviour) is also a system that stores personal information, or at least information that is highly personalised in terms of what is gathered and how it is captured, organised, used and shared. This system does have a goal of self-improvement in the broadest sense, since it will be used to manage information pertaining to all aspects of students' lives, both academic and beyond.

STUDENTS' INFORMATION BEHAVIOUR

The ways in which students engage with information has been extensively studied, particularly within the Information Science literature. Some studies focus exclusively on information behaviour related to academic tasks (Lee, Paik & Joo, 2012), although others recognise the interconnectedness of everyday and academic information needs (Given, 2002; Sin & Kim, 2013) and that distinguishing between the two is a "false dichotomy" (Given, 2002, p. 18). In our study we took the latter view, that students' information systems include tools and behaviours for accessing both academic and everyday information.

Studies of students' information behaviour have variously focused on students' information needs (Chung & Yoon, 2015; Ossai-Onah, 2013), their information-seeking strategies (Ajiboye & Tella, 2007; Nadzir, 2015; Ossai-Onah, 2013), and the range of resources that students consult (Ajiboye & Tella, 2007; Chung & Yoon, 2015; Lee, Paik & Joo, 2012). These studies have resulted in catalogues of information needs, information resources consulted and information seeking strategies, as well as analyses of the relative importance of such needs, resources and strategies.

A few studies investigate the devices and technologies that students use in the process of accessing, storing and using information (for example Chung & Yoon, 2015), something of interest to us from the perspective of Information Systems. Our study adds to this limited literature.

Many of the studies of students' information behaviour are descriptive, making little attempt to develop or frame their results in terms of theoretical understandings. Some have sought to relate needs, strategies and sources to student characteristics such as level of study, field of study and gender (Ajiboye & Tella, 2007; Sin & Kim, 2013), while others emphasise the situational nature of information behaviour (Given, 2002). One framework that has been used in understanding information behaviour (Given, 2002) comes from Savolainen's (1995, p. 268) concept of "mastery of life" or how people "keep things in order" that analyses problem solving behaviours in terms of the activities of (1) prioritising problems, (2) selecting information sources and channels, (3) seeking broader, orienting information and (4) seeking applicable, practical information, with these activities being influenced by situational factors. Savolainen (1995) identified four approaches to "mastery of life" that reflect whether individuals approach tasks optimistically or pessimistically and the extent to which tasks are viewed as cognitive or individuals allow affective factors to dominate their actions.

Towards the end of the 1990s, researchers began to explore the idea that not all information seeking was goal directed (Erdelez, 1997; Erdelez 1999; Savolainen, 1995). Bates' (2002) "integrated model of information seeking and searching" encompasses both purposeful, or goal-directed information behaviour and what is termed *incidental information acquisition*. In the former, the individual is aware of an information need and sets out to find information to meet that need. In the latter, the individual becomes aware of information as a result of being in a place, or as a result of some interaction or engagement, rather than in a directed fashion (Williamson, 2005). Bates argued that the majority of knowledge is acquired through "being aware, being conscious and sentient in our social context and physical environment" (Bates, 2002, p. 4).

Williamson's ecological model of information seeking and use (Williamson, 2005) builds on Bates' (2002) model and considers the use that an individual makes of a range of information sources as being influenced by "ecological" elements". The model was influenced by a view of people as "self-creating, but within contexts" (Williamson, 2005, p. 130), where those contexts might include biological, social, economic and physical circumstances. The emphasis is on the relationship between the individual and the information sources, which Williamson identified as including institutional sources, media and personal networks. Williamson's more recent work has applied her model in diverse contexts and has been particularly interested in people's preferences for different information sources and the creation of user-centric information portals that deliver information suited to self-select user types (Williamson & Manaszewicz, 2002).

The recognition that the ways in which people approach information-related tasks is closely linked to their approach to life in general (Savolainen, 1995), as well as the idea of information behaviour emerging from an ecology of contextual elements (Williamson, 2005), appear to be useful in understanding the behaviour of undergraduate students in all its variety.

RESEARCH QUESTIONS

Our interest lies in understanding the technologies employed and the information behaviour of students entering university and the role that university resources play in their personal information systems. Technology devices are of interest to us as they enable the access to information sources, as well as the means to capture, organise and share information. We are particularly interested in students' information behaviour in the university context and how students use the information sources that the university provides as part of our ongoing interest in improving student learning. This paper therefore addressed the following research questions:

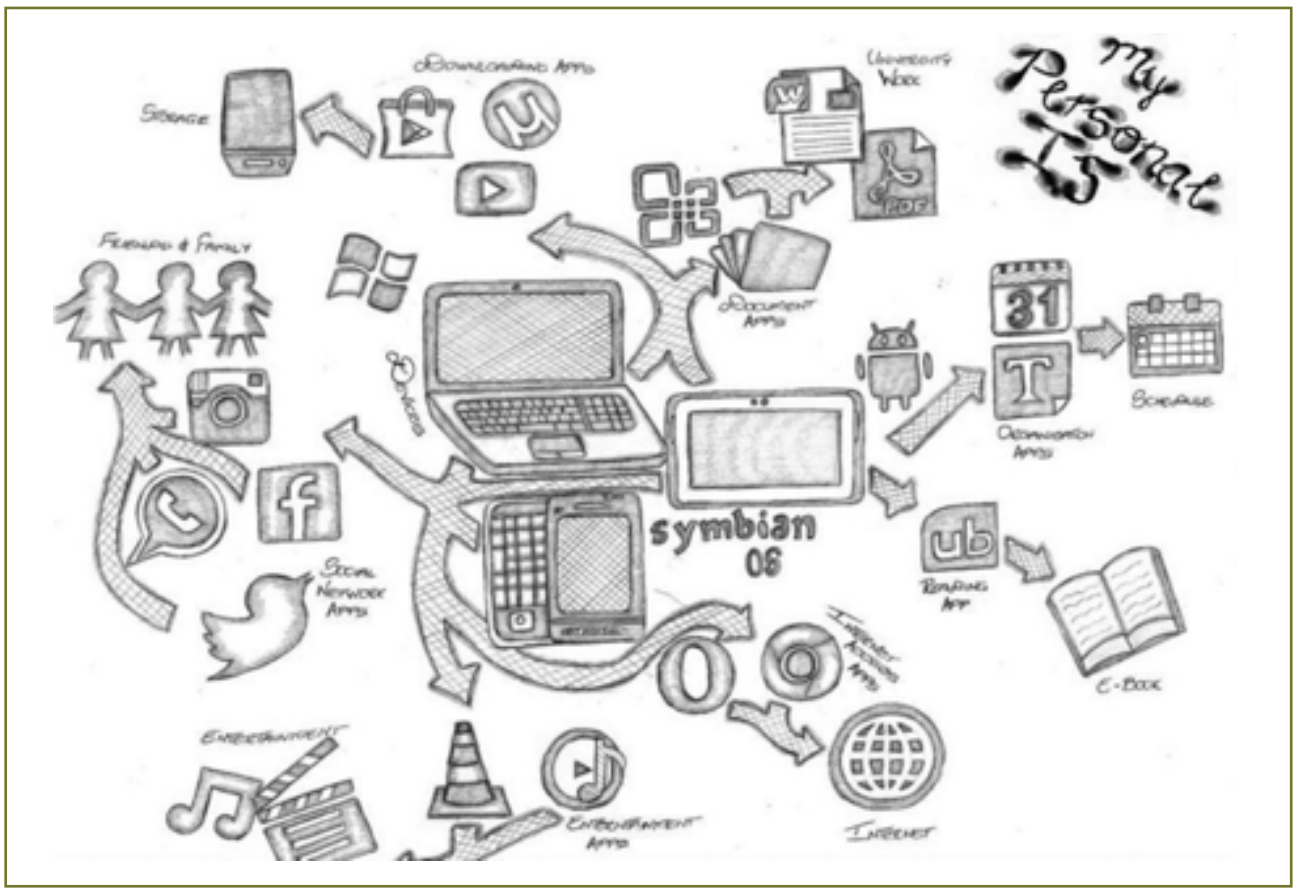
1) What technology devices do students use to access and manage information?
2) What sources of information do students use?
3) To what extent do students use the information resources provided by the university?
4) What theoretical models aid understanding of the variety in students' personal information systems and the implications of this for universities?

DATA COLLECTION

In the first two weeks of the "Fundamentals in Information Systems" course, students are encouraged to reflect on the information tools (both traditional and electronic) that they use to find and manage information. "Tools" include both the technologies ("devices") and applications ("apps") that they use or may want to use. Students share information about their favourite information tools and how they use them through an online forum. They are also challenged to try out new tools and comment on the posts made by other students.

Students are also asked to draw a "rich picture" of their own personal information system. Rich pictures are a tool used in Information Systems to depict the complexities of system components and their relationships (Avison & Fitzgerald, 2003) and are one of the Information Systems tools that students learn about during the course. Students were asked to draw a rich picture depicting the different sources of information and the tools to access and manage information that they were either currently using or intended to use during their university studies. An example of one of the pictures submitted is shown in Figure 1.

FIGURE 1: EXAMPLE "RICH PICTURE" OF A STUDENT'S PERSONAL INFORMATION SYSTEM



Pictures were submitted electronically in a variety of formats. Some were drawn using software tools such as Word, PowerPoint or Visio and submitted in software-specific or pdf formats. Some students constructed collages or drew pictures freehand and scanned or photographed the results, submitting them in pdf or jpg formats. Students uploaded their pictures to the learning management system (LMS). In total, 325 pictures were collected in 2013, 456 pictures in 2014 and 240 pictures in 2015.

ANALYSING AND INTERPRETING THE DATA

For the purpose of this analysis, the pictures were downloaded from the LMS and any identifying information (names and/or student numbers) was removed. Each file was renamed with the year and a unique number and saved in pdf format. The three data sets (2013, 2014 and 2015) were then imported into Atlas.ti for coding. A millennial coder was employed to identify and code each item on each picture. The coder's brief was to identify the specific technology or application that was referenced in the pictures. It was important to use a coder who was familiar with the technologies and applications in use by the students and who was sufficiently "at home" online to be able to track down references (textual and graphical) to obscure applications and technologies.

Once this initial coding was complete, the researchers created code families to group related concepts together. For this paper, given our research questions, the focus was firstly on the technology devices used to source and manage information and secondly on the sources of information that students consulted. Technology devices were fairly easy to group into categories such as cellphones, laptops, tablets and desktops.

Analysing the sources of information in the student's personal information systems proved more difficult and resulted in some debate as to what constitutes an information source. We distinguished between sources of information and tools used to store, organise and share information once it had been collected. The latter were not analysed for this paper. So, for example, an app used to manage tasks was not considered a source of information, despite the fact that students might consult such an app daily to identify tasks. Similarly, a book was considered an information source, while files were considered tools for managing information. In analysing the information sources, we grouped sources based on the characteristics of the providers of information, in keeping with Williamson's (2005) model, but identified different categories than those in the original model.

In interpreting the data, there are two areas of uncertainly to be borne in mind. Firstly, although students were asked to depict the information systems that they were using at the time, they were also in the process of exploring new tools for information management. They were exposed to alternative technologies and information sources through viewing and commenting on other students' personal information systems. So in interpreting the data, it is important

to remember that the pictures may to some extent represent aspirational information systems that students could see themselves using in the future. While this means that we cannot draw firm conclusions about the information system that the students were using, we believe that the data still gives a fair reflection of students' information behaviour.

Secondly, for most of the students this data was collected in the second and third weeks of their first semester of study. This means that their personal information systems may have reflected more of their concerns with social information, which would have been a priority during the recent long vacation following the end of school and a socially intensive university orientation programme. On the other hand, the data may also have been biased towards the information that they would need for their university studies, as they were freshly arrived in the university context and actively involved in trying to navigate the new environment. Without further investigation it is difficult to know to what extent these biases are present in the findings.

WHAT TECHNOLOGY DEVICES DO STUDENTS USE?

Table 1 shows the frequency with which different devices appeared in the students' pictures from 2013 to 2015. Note that some pictures included more than one reference to a device and so (1) the number of references to a device could exceed the number of pictures analysed and (2) the percentages shown are not strictly the percentage of pictures with references to a device, but they are indicative of the prevalence of the device in the data as a whole.

Almost all the pictures included references to cellphones and some included more than one reference. In 2013, all but nine of the cellphones depicted were recognisable brands and models of smartphones, in 2014, all but five cellphones and in 2015, all but one cellphone. While some of these may represent student's aspirations, it seems clear that most students have smartphones and view them as a central technology in their information-related activities. (In the table below, only smartphones are counted as computing devices; cellphones that could not be identified as smartphones have been omitted.)

Laptop computers are more prevalent than desktop computers in students' personal information systems and in 2015 almost all students made mention of laptops. Tablet devices are similarly appearing increasingly often, with 63% prevalence in 2015.The prevalence of desktop computers declined between 2013 and 2014, but in 2015 more students included desktop computers in their diagrams, perhaps indicating that more students had access to multiple devices. These results are not dissimilar to what has been observed in other studies. Chung and Yoon (2015) ranked the use of devices by international students at the University of South Florida, from most used to least used as: laptop computer, smartphone, tablet computer, eBook reader, and desktop computer.

Although there are many references in the student pictures to cloud storage, a large number make use of external storage devices such as external drives, USB drives and memory (SD) cards to store information. This may well be a reflection of some challenges in connecting to remote storage services, including reliable access and cost. In 2014, three students made references to wearable computing devices, one to Google Glass and two to smartwatches. These may well have been aspirational, however.

TABLE 1: REFERENCES TO TECHNOLOGY DEVICES IN STUDENTS' PERSONAL INFORMATION SYSTEMS

Device	2013 n=325	2013 %	2014 n=456	2014 %	2015 n=240	2015 %
Smartphone	324	100%	445	98%	348	145%
Laptop computer	247	76%	355	78%	225	94%
Tablet device	94	29%	162	36%	150	63%
Desktop computer	113	35%	134	29%	149	62%
External storage	106	33%	273	60%	400	167%
Wearables	0	0%	3	1%	0	0%
Portable music device	88	27%	75	16%	39	16%
Television	58	18%	18	4%	22	9%
Radio	29	9%	12	3%	3	1%
Digital camera	55	17%	7	2%	2	1%
eBook reader	13	4%	21	5%	7	3%
Gaming console	17	5%	21	5%	20	8%
Printer	8	2%	5	1%	2	0%
Scanner	4	1%	2	0%	1	1%

The convergence of devices can be seen in the decline from 2013 to 2015 in the number of references to devices such as television sets, radios, digital cameras and music players. Because students still made references to radio and television programmes and music websites in 2015, we can assume that they are using their other computing devices to access this content. The diagrams included references to streaming television and radio apps and music apps, but this data has not yet been analysed.

The prevalence of e-book readers and gaming consoles in students' personal information systems did not change much between 2013 and 2015. This may reflect a reasonably constant proportion of students with interests in reading and gaming respectively. However, the prevalence of these devices does not necessarily reflect the full extent of the use of e-books or gaming, since students may also access e-books and games from their computers or tablets. Students also made references to e-book applications and gaming applications, but this data has not yet been analysed.

Students' information systems are largely paperless, with printers and scanners playing an insignificant role. This may be due to the cost of printing or to students embracing environmental concerns, but that cannot be established from the data.

WHAT SOURCES OF INFORMATION DO STUDENTS USE?

Lee et al. (2012) classified the information sources students' use as human, printed, online and mass media, similar to the classification used by Nadzir (2015). These classifications relate more to the seeking strategy and hence the format that information is stored in, and so do not give insight into other information characteristics like the credibility or the nature of the information being sought. Williamson (1998), working with the information behaviour of older people, identified three types of information sources: institutional sources, media and personal networks, which gives greater insight as to the origins and nature of the information. The data that we had did not allow a similar categorisation. Instead we categorised information sources as generic, academic and specific, based on the extent to which we could perceive the nature of the information being sought, as explained below. The academic sources align with Williamson's institutional resources, the generic resources include personal networks, as well as other tools available to individuals to use, while the specific sources are provided by organisations, in the same way that media companies provide information.

All items in the students' pictures that could be considered information sources were identified and then similar types of information sources were clustered together based on the type of information that we could deduce was sought from this source. Table 2 shows the types of information sources identified. The indented rows show the most frequently depicted information sources within each type.

Some information sources were clearly associated with specific types of information, for example the website of a retail organisation would provide information about their products and a weather service would provide information about the weather. However a large number of information sources were generic in that it was not possible to discern what kinds of information might be provided from that source. Generic information sources were analysed in three categories, social media, people (not associated with academic roles) and other generic sources. References to people in academic roles were categorised as academic information sources.

TABLE 2: TYPES OF INFORMATION SOURCES IN STUDENTS' PERSONAL INFORMATION SYSTEMS

Nature of source	2013 n=325	2013 %	2014 n=456	2014 %	2015 n=240	2015 %
Generic information sources						
Social networks	**1045**	**322%**	**1538**	**337%**	**1032**	**430%**
WhatsApp	242	74%	380	83%	260	108%
Facebook	280	86%	369	81%	213	89%
Twitter	201	62%	281	62%	131	55%
Other generic sources	**399**	**123%**	**465**	**102%**	**208**	**87%**
Internet	53	16%	181	40%	10	4%
YouTube	159	49%	137	30%	140	58%
Google	149	46%	73	16%	37	15%
People (not academic)	**250**	**77%**	**323**	**71%**	**18**	**8%**
Friends	132	41%	203	45%	8	3%
Family	53	16%	62	14%	3	1%
Academic information sources						
All academic sources	**294**	**90%**	**252**	**55%**	**261**	**109%**
LMS	98	30%	149	33%	64	27%
Books	74	23%	75	16%	40	17%
Sources of specific information						
Retail information	93	29%	207	45%	147	61%
Leisure and cultural	160	49%	99	22%	97	40%
News media	164	50%	85	19%	89	36%
Transport and travel	21	6%	52	11%	148	62%
Weather	16	5%	7	2%	26	11%
Business and investing	9	3%	5	1%	13	5%

Social media dominates students' personal information systems and it is clear that students consider social media their most important source of information. All pictures included one or more references to social media with an average of three distinct social media for each student, somewhat more than the 2.5 social media per student identified by Chung and Yoon (2015). The social media that dominate are WhatsApp, Facebook and Twitter.

People (other than those that students encounter in their academic pursuits) included friends, family and depictions of unspecified people. Students no doubt use social media applications to communicate with people in this category and we debated whether to analyse people and social media together. However, social media puts students in touch with a far wider range of people (as is evident in the more frequent references to social media), so these types of information sources seemed to warrant separate discussion. The 2015 data included far fewer references to people than the earlier data and it is not clear why.

Other generic information sources referenced included the Internet and search engines, such as Google or DuckDuckGo, used to access the World Wide Web, as well as general information sites such as YouTube and Wikipedia.

Several information sources are clearly associated with academic activities, the most frequently depicted being the university's learning management system. Books, e-books, textbooks and reference books such as dictionaries were

the second most often mentioned academic resource, although few students included the library in their information systems (nine students in 2013, four students in 2014 and zero students in 2015). This aligns with a study carried out in Botswana, where only 6.4% of students used the library (Ajiboye & Tella, 2007) in favour of online resources.

Few students depicted lectures as a source of information (sixteen students in 2013, nine students in 2014 and four students in 2015) and even fewer included academic staff in their pictures (two students in 2013 and zero students in 2014 and 2015). A study that looked specifically at information behaviours around academic tasks has shown that undergraduate students rate academic staff highly as information sources (Lee et al., 2012), but that was carried out in Korea and might reflect different cultural approaches to studying. Other people that students encounter in the academic context, including classmates and project teammates, were represented and we identified them as sources of academic information. Educational websites such as Khan Academy, Mindset Learn and Master Maths were also mentioned by students, although infrequently.

Specific information sources reveal categories of everyday information that students seek. Retail information sources were frequently depicted in students' pictures, showing that information for making buying decisions is important to them. Less important is information about leisure and cultural pursuits including music, movies and television series, events, sports, games, dining out and religious activities. Traditional news media featured as information sources, including television, radio, magazines and newspapers, although several of these are consumed in electronic form. Students access information relating to their travel and transport including applications for bus and train timetables, navigation tools and websites and applications providing traffic information. A few students seek information about the weather and access websites relating to business and investing. The kinds of information sought are not dissimilar to previous studies, which have shown that, in addition to academic information, students seek information about health, personal development, current affairs, entertainment, business, transportation and accommodation (Chung & Yoon, 2015, Nadzir, 2015, Ossai-Onah, 2013, Sin & Kim, 2013).

The increase in 2015 of the use of these specific information sources seems to reflect an increase in the availability of such sources and the number of students that have access to them. In particular, the student pictures in 2015 make mention of a greater variety of mobile apps that fall into this category.

DO STUDENTS USE UNIVERSITY INFORMATION RESOURCES?

In answer to our third research question, the sources of information provided by the university are depicted in students' personal information systems less often than other generic and specific information sources. It may be tempting to suggest that social and generic sources of information dominate because students compiling these personal information systems were only two weeks into their first year of university at the time. However, at this point they are likely to be beginning to apply their minds to the sources of information that relate to their academic work; they are fresh from campus introduction activities that include tours of the university libraries and yet the library gets very little mention. Similarly low use of such sources was reported by Chung and Yoon (2015), whose study applied to students at all levels of study. Chung and Yoon's study showed that while students frequented libraries, they seldom used librarians and library catalogues in their information-seeking strategies.

Lectures and lecturers were alarmingly absent from the personal information systems that students depicted. In presenting earlier versions of this paper to colleagues and to the South African Computer Lecturer's Association conference (SACLA 2015), we found academic staff quick to find reasons why this should be so, and to defend the relevance of universities' traditional information sources, particularly the role of lecturers, but the very dramatic differences in the frequency with which academic sources feature ought to sound a warning and suggests that universities might want to pay attention to developing more user-centric information sources (Williamson and Manaszewicz, 2002).

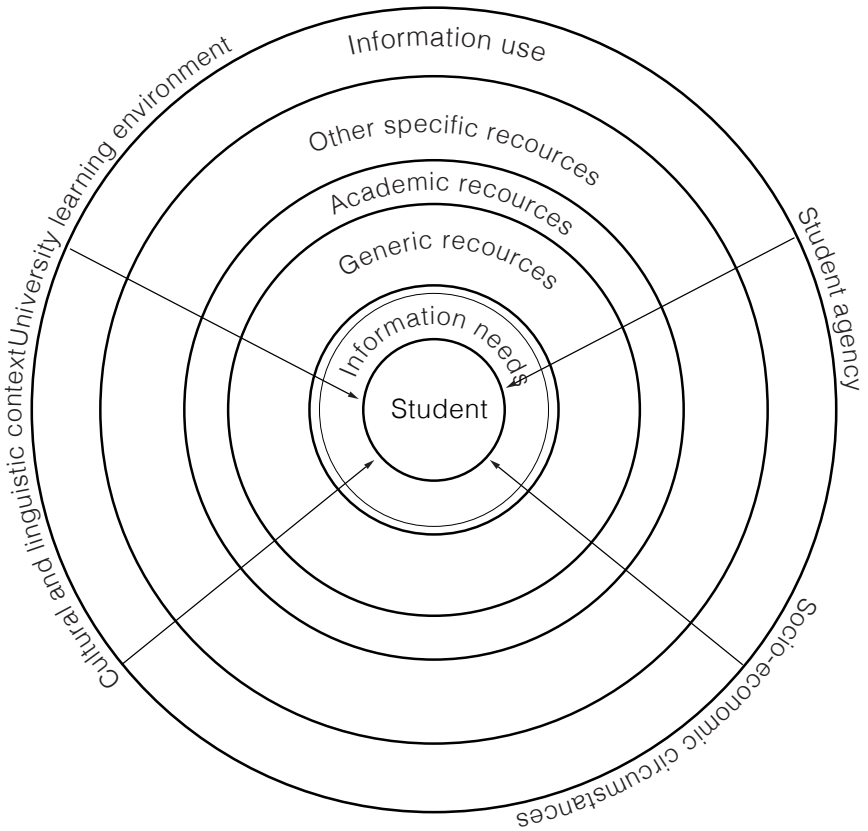
WHAT THEORETICAL MODELS AID OUR UNDERSTANDING?

Williamson (2005) made the point that information seeking and use is highly contextual and that contextual constraints frame these behaviours. In her study of the information behaviour of older people, she identified biological, social, economic and physical circumstances as providing these contextual constraints. We sought ways to understand the contextual constraints that students face.

Prior research into student success at the University of the Witwatersrand has identified three sets of conditions that impact on student success; firstly the student's biography, which includes their socio-economic, cultural and linguistic background; secondly, the learning environment created by the institution; and thirdly the student's agency or the extent to which the student can negotiate the teaching and learning processes (Cross, Shalem, Backhouse & Adam, 2009). Thus we propose using these elements as the contextual constraints for an ecological model of student information-seeking behaviour based on Williamson's (2005) model (the outermost layer of Figure 2).

In the inner layers of the model we depict the three different student information sources that we identified from the data as concentric bands where the size of each band reflects the frequency of use of each source. How the use of these sources is mediated by the contextual constraints is discussed here, based on literature.

FIGURE 2: ECOLOGICAL MODEL OF STUDENT INFORMATION SEEKING AND USE



(Adapted from Williamson, 2005)

Students' socio-economic, educational and linguistic backgrounds influence the technologies that they have access to and experience of, and so constrains the configuration of their personal information systems. By making explicit the idea of a personal information system and exposing students to a range of devices and applications that are available, they are encouraged to develop a richer set of information behaviours that they can draw on in their studies. The pictures reveal that most students, whether aware of it or not, already have a rich personal information system incorporating digital and physical resources, but it is also clear that some are more sophisticated than others.

Most students in our study have access to more than one digital device to access information, and the university supplies desktop computers and Wi-Fi access for mobile devices. Although students at the University of the Witwatersrand make extensive use of digital and online resources, studies of student information behaviour in other African universities (Ajiboye & Tella, 2002; Baro et al., 2010; Oladokun, 2010) show that students depend on physical resources when electronic resources are not available or are difficult to access. Thus the information services provided by the university, both traditional and digital, are an important contextual influence on students' information behaviour.

Research has shown that all students newly arrived at university are disadvantaged by their lack of understanding of the academic discourse and expectations (Mgqwashu, 2009) and that some lack specific skills or the self-efficacy needed to succeed (Cross, Shalem, Backhouse & Adam, 2009). Students need to develop sophisticated and highly individual personal information systems that can deal effectively with degrees of visibility of information, task urgency and workflows (Mizrachi & Bates, 2013). Each student's ability to do this effectively depends on their "mastery of life" approaches (Savolainen, 1995), skills, access to technologies and creativity, as well as prior exposure to effective information behaviour.

In particular, adjusting to the university environment requires accessing information about the university discourses, resources and expected behaviours that students do not know that they lack. A rich information system that caters for both goal-directed information seeking (used, for example, to find information to complete an assignment) and incidental information acquisition (used, for example, to understand expected ways of behaviour), can assist students in acquiring the knowledge and skills that are critical to successful navigation of university studies (Cross, Shalem, Backhouse & Adam, 2009; Mgqwashu, 2009), particularly the knowledge that they do not yet know that they need. Incidental information acquisition also has the benefit of resulting in positive feelings that boost a student's sense of agency (Erdelez, 1999).

Williamson's model distinguished between goal-directed information seeking and incidental information acquisition. The data that we have does not enable us to make this distinction, but goal-directed information seeking is likely to make use of academic and specific sources, while prior studies suggest that students will find incidental information from social media and other generic sources (Erdelez, 1999). These generic information sources may thus be important for students in developing their understanding of the expectations of the academic environment needed to succeed at university (Cross, Shalem, Backhouse & Adam, 2009; Mgqwashu, 2009).

This ecological model of student information behaviour assists our understanding of the variety of student information behaviour and suggests that providing uniform information resources for students is unlikely to be a successful strategy.

WHAT DOES THIS MEAN FOR PRACTICE?

Latham and Gross (2011) observed the Dunning-Kruger effect in the context of information literacy skills. This is when people with low skills in a particular domain are unable to recognise their own deficiencies in the domain (Kruger & Dunning, 1999) and are thus unlikely to take action to learn the skills that they do not know they do not have (Gross, 2005). This effect makes it important to make students aware of the range of information tools and resources that are available to them and to develop skills in information literacy. Such interventions not only teach applicable skills, but can also work to counter the Dunning-Kruger effect, changing students' conceptions of what information literacy is and developing a more realistic idea of their own information literacy skills (Latham & Gross, 2011).

Training interventions do not, however, always result in long-term changes in information behaviour (Chen, 2015), a finding supported by Savolainen's idea of how psychological types influence information behaviour. By taking an ecological perspective of students' information behaviour, the need to develop information sources that are tailored to different kinds of student becomes clear. This may need to go beyond flexible digital information portals to consider changes to traditional modes of teaching and introducing the flexibility for students to be able to self-select modes that suit them best. Reflective and collaborative exercises such as the one described in this paper expose students to multiple information tools and behaviours and facilitate each student building their own particular personal information system.

CONCLUSIONS

Students' information behaviour can be understood in terms of an ecological model that maps the information sources they use and the contexts that influence their success in accessing information. University students have to develop a complex personal information system and master a range of information behaviours in order to succeed in their studies.

Students access a wide range of generic information sources, with social media applications dominating their information behaviour. These generic sources of information have the potential to support students' incidental information acquisition, which is important in addressing their common lack of knowledge about academic discourses and expectations on entering university.

For students, the learning management system is the most important academic information source, with traditional academic activities of lectures playing a small role in their information gathering. In particular, members of the academic staff are not seen as significant sources of information for students. This observation supports moves towards blended learning and away from traditional modes of instruction. The role of academic staff may well need to shift from being presenters of academic information towards being choreographers of learning materials delivered through other media. Uncomfortable as this change appears, refusing to renew higher education pedagogies in the face of mounting evidence that existing pedagogies are considered irrelevant by students seems irresponsible. Rather, the university might take steps to better understand and own the information behaviour of its students and proactively aim to both adapt pedagogies and to improve the ways in which students work with information.

Most undergraduate students use smartphones and laptop computers, with desktop and tablet computers as an alternative. Although students use cloud storage options, they mostly make use of physical storage devices that do not depend on access to networks. This suggests that it might be worth the institution providing smartphones to the few who do not have them in order to (1) facilitate access to information sources that will provide much-needed incidental information and (2) facilitate teaching and learning activities designed to take advantage of the capabilities of smartphones. The provision of reliable, free wireless network access should also be a priority for institutions.

This paper has examined students' information sources and the technology devices they use to access them. Further research is needed to better understand the types of information that are being accessed through generic information sources and students' uses of academic information sources, as well as more in-depth evidence of how context impacts information behaviour. In 2015, we expanded the assignment from which this data was collected to include additional elements which will facilitate such further investigations.

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POSTGRADUATE DISSERTATION ASSESSMENT: EXPLORING EXTANT USE AND POTENTIAL EFFICACY OF VISUALISATIONS

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ABSTRACT
In the context of assessment, two specific challenges face South African academics. The first is that their universities have experienced an unprecedented increase in postgraduate students without a concomitant increase in supervision capacity. The second challenge is that many South African students are studying in a second or third language and struggle to express themselves in English. It is notoriously difficult to write text that is easy to read. Examiners are thus finding it challenging to maintain their own existing high standards of consistency, accuracy and fairness. This paper focuses on identifying a way of making the assessment of dissertations more efficient, while retaining rigour and fairness. In so doing, we want to provide students with a tool that will help them to communicate their research more effectively. In seeking an intervention, we noted the emerging use of visualisation as a communication facilitator in other areas of academia. Given the innate human ability to understand and remember visual representations, and the deep level of cognitive processing required to produce such visualisations, the considered inclusion of visualisations could be the means we are seeking. In this paper we report on an investigation into the extant use and potential usefulness of visualisation in a number of dissertations. We also explore supervisor expectations with respect to the use of visualisation in research reporting. Based on our findings, we propose that a discourse be opened into the deliberate use of visualisation in postgraduate research reporting.

KEYWORDS
visualisation, assessment, postgraduate, dissertation

INTRODUCTION

Assessment is a core activity in higher education. Rowntree (1987) argues: "If we wish to discover the truth about an educational system, we must look into its assessment practices" (p. 1). The pressure for universities to demonstrate effective performance is evident from the studies of Pounder (1999) and Bitzer (2010). More recently, the drive has focused on ensuring the quality of the contribution (Simmonds & Du Preez, 2014). In this paper we focus on *dissertation* assessment, and specifically the role that visualisation could play in improving assessment practices.

Academics in South African universities in particular, are under increasing pressure to deliver postgraduate students. There are a number of reasons for this, including the following:

1. Universities across the globe are enrolling increasing numbers of postgraduate students (Taylor, 2002; Kruss, 2006). More students, with the same number of academics under increasing pressure, mean more dissertations to be assessed in the same time period (Van Biljon & De Villiers, 2013). For example, at the University of South Africa the number of dissertations more than doubled from 2010 to 2012 while the supervision capacity did not increase accordingly (ibid).
2. I'Anson and Smith (2004) mention the pressure that comes from millennium trends in higher education, including widening access, coping with large groups of students and the increasing occurrence of plagiarism.
3. The realities of South African society have led to the admission of student cohorts who vary in readiness for postgraduate study. This places additional pressure on supervisors to provide the necessary interventions the students need to meet the exit standards of postgraduate study (Van Biljon, Van Dyk & Naidoo, 2014).
4. Besides postgraduate supervision and evaluation, university lecturers also have other responsibilities like tuition, community engagement, academic citizenship, administration and carrying out their own research (Sanders & Pilkington, 2014; Bezuidenhout, 2015).
5. South Africanw students are often studying in a second or third language (Pretorius, 2002; Webb, 2002). Depending on their English proficiency this may add to the difficulty of communicating their research in English (Armbruster & Anderson, 1985; Herminingsih, 2013), the predominant language of instruction in South African universities.
6. There is a clear need for greater consistency in assessment of dissertations (Webster, Pepper & Jenkins, 2000). Indeed, Brits et al. (2014) report on a study comparing mini-dissertation grading that found an unacceptably high variance in terms of grades awarded, so this is another issue that adds pressure on examiners.

An in-depth discussion on assessment methods is beyond the scope of this paper, but the studies mentioned support the argument that there is pressure on examiners (not all of whom are equally experienced) to deliver high-quality assessments under severe time constraints. South African examiners are challenged by the need to apply assessment metrics consistently under these pressures. This necessitates some kind of support mechanism to ease the assessment process while maintaining fairness.

The time taken to examine a master's dissertation is more or less directly proportional to the number of pages since the examiner has to read through the entire dissertation in order to assess individual criteria and assign a final grade. Many examiners will attest to the value of an abstract in delivering a quick overview before they embark on the detailed reading process. It helps them by giving a meta-view of the content and establishes a set of expectations in the examiner's mind. Indeed, Brown and Atkins (1988) specifically recommend that examiners start off by "getting a global impression" and that they do so by reading the title and abstract and then the final chapter. They argue that this will help the examiner to get a quick view of the problem the student tackled, within its context.

However, textual, summary-like portions of the dissertation have limitations for both assessor and student. The assessor effectively processes text sequentially and its limited length constrains its information payload. The student, on the other hand, needs a solid mastery of English in order to be able to deliver a coherent, readable piece of text that summarises the research effectively. Even if these limitations are set aside for the present, it must be acknowledged that an abstract delivers only an overview of the research report *as a whole*. It does not necessarily deliver insights into the level of knowledge mastery achieved by the student. Since there is also a global drive to assess dissertations using specific institutionally defined criteria (Saunders & Davis, 1998; O'Donovan, Price & Rust, 2004) this quick scan probably no longer suffices as it used to when Brown and Atkins (1988) published their research. To carry out a fine-grained assessment the textual abstract falls short.

In searching for an intervention, we became aware of the increased use of visualisation in common practice. Some conferences have recently started requiring academics to provide video previews of their papers, and Elsevier asks for graphical abstracts of accepted papers.[1] CHI 2014's website[2] said the video previews were intended to "… help them (readers) discover interesting and important work …". Elsevier's website states that graphical abstracts: "… allow readers to quickly gain an understanding of the main take-home message of the paper". Hence these more visual summaries essentially augment the papers, providing the potential reader with a snapshot that can be quickly assimilated *as a unit*, in parallel, far more efficiently than reading the entire paper or, apparently, the textual abstract.

Visualisations, in general, have characteristics that make them powerful communication mechanisms (Card, Mackinlay & Shneiderman, 1999). Most humans interpret images more quickly and effectively than they do words (Bresciani & Eppler, 2009). According to Burkhard (2005; p. 242) "knowledge visualisation examines the use of visual representations to improve the transfer and creation of knowledge between at least two persons". Such visualisations can be expected to communicate very effectively and efficiently. The publishers we mentioned may well have identified a way to improve assessment. Their emergent practice led us to wonder whether visualisations might have a role to play in easing assessment of postgraduate dissertations too. This raises the question: *"How useful are visualisations in improving the effectiveness, efficiency and satisfaction of examiners?"* Visualisations require additional effort and expertise; their use is optional and not regulated or specifically rewarded in the dissertation evaluation criteria. It would thus be interesting to see how frequently they were used, if at all. An empirical investigation is out of the question since we cannot ethically assign students to experimental and control groups to be evaluated by the same examiner, with or without visualisations. Therefore we considered the questions that could realistically be investigated retrospectively.

The first research question was: *"How prevalent are visualisations in examined dissertations?"* If visualisations were indeed used, then it might be useful to know something about their distribution, introducing the next two questions. *"In which parts of the dissertation are they situated?"* and *"Does their use have any impact on the student's mark?"*. These three questions were formulated to help us to gain an understanding of the extant use and possible usefulness from a quantitative perspective. From a qualitative perspective, we also need to consider the supervisors' viewpoints to gain insights into the possible usefulness of visualisations in postgraduate dissertation assessment. We carried out an investigation into how visualisation had been used in postgraduate dissertations published over a 10-year period at one South African university. The sample of 22 information systems dissertations represents 73% of the dissertations completed during that period (2002-2012).

We found that visualisations did indeed appear in these dissertations and we also found evidence that their distribution across the dissertation chapters seemed to impact the final grade. Such a finding, especially since the sample is small and the correlations were relatively weak, does not imply causality. It does, however, suggest that we need to open up a discourse on the use of visualisation in postgraduate assessment. The interviews with supervisors also revealed specific interesting expectations about the use of visualisations in dissertations.

In the next section we provide an overview of related literature on visualisation in information and knowledge transfer before we present our study.

1. http://www.elsevier.com/journals/surface-science-including-surface-science-letters/0039-6028/guide-for-authors
2 https://chi2014.acm.org/

LITERATURE REVIEW

KNOWLEDGE VISUALISATION CONSTRUCTS

It is necessary to understand the basics of knowledge visualisation before proceeding to any discussion of how these could be utilised. The fundamental constructs are those of *data, information* and *knowledge*. These can be described as follows (Chen et al., 2009):

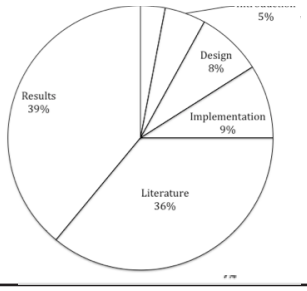
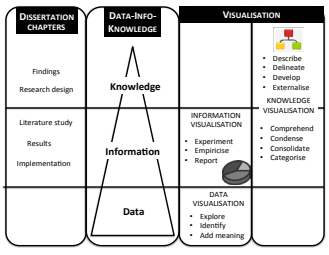
- **Data** – a representation of facts, concepts, or instructions in a formalised manner suitable for communication, interpretation, or processing by human beings or by automatic means.
- **Information** – the meaning that is currently assigned by human beings or computers to data by means of the conventions applied to the data.
- **Knowledge** – understanding, awareness, or familiarity acquired through education or experience. Anything that has been learned, perceived, discovered, inferred, or understood. The ability to interpret information.

According to these definitions, processed data becomes information and interpreted information becomes knowledge. The processing can be automated to a large extent but human cognition remains central to the process of sense-making. This means that each level of abstraction adds bias due to the subjective selection of processing procedures. The only way to manage the accountability of the process is to state the assumptions and take cognisance of the constraints at each step of the process (Muller, van Biljon, & Renaud, 2012).

Any study of knowledge visualisation should recognise the connection to the more established fields of information and data visualisation. Data visualisation is the use of a visual representation to gain insight into an information space supporting the transitioning of data to information (Chen et al., 2009). Information visualisation supports pattern identification and knowledge creation (Card et al., 1999). Knowledge visualisation's goal is that knowledge can be better accessed, discussed, valued, transferred and generally managed (Eppler & Burkhard, 2007). Burkhard (2005) provides a discussion on the essential differences between data, knowledge and information visualisation.

Van Biljon and Renaud (2015) summarised the differences between data, information and knowledge visualisation presented by Burkhard (2005) and supplemented that with examples, as depicted in Table 1.

TABLE 1: DIFFERENCES BETWEEN DATA, INFORMATION AND KNOWLEDGE VISUALISATION

	Data visualisation	Information visualisation	Knowledge visualisation
Goal	Support exploration of data using graphical metaphors	Support exploration of data using graphical metaphors	Support exploration of data using graphical metaphors
Benefit	Makes data mining more accessible	Identification of patterns, exploration of large data sets	Augmenting knowledge transfer between individuals; communicating knowledge
Context	A large volume of data which needs to have meaning identified	Explicit data such as facts and numbers	Experiences, insights, instructions, assumptions
Answers question	Where	What	Why, Who, How
Example	See Figure II 	Depiction of an author's research areas 	See Figure I 

Source: Van Biljon & Renaud, 2015

Knowledge visualisation's primary aim is knowledge creation and transfer (Burkhard, 2005; Eppler & Burkhard, 2007). In education, the essence of the educational assessment process requires knowledge to be communicated (transferred) by means of academic writing. This, then, is where knowledge visualisation might well play a mitigating role.

Eppler and Burkhard (2007) structure the knowledge visualisation formats into seven main groups, namely: structured text/tables, mental (non-material) visualisation and visual storytelling, heuristic sketches, conceptual diagrams/ concept maps, visual metaphors, knowledge maps, and graphic interactive environments. Taking cognisance of the variety of visualisation formats is important in terms of grasping the potential for knowledge creation, representation and transfer.

In this study the focus will be on structured text (tables) and conceptual diagrams with some examples of visual metaphors and knowledge maps that will be classified as figures. The dissertation format limits the visualisation to the constraints of a two-dimensional static model. A model is an abstracted, simplified, concise representation of something else (phenomenon) in the world for the purpose of comprehending the phenomenon (Weber, 2012). Models compromise precision to achieve cognitive economy and therefore models and knowledge visualisations have the same focus and some of the same constraints.

APPROPRIATENESS OF VISUALISATION IN RESEARCH REPORTING

We will consider the potential benefits of visualisation from the perspective of the consumer (supervisor) and the producer (student).

First, the visualisation consumer, who, according to the literature, should be able to understand the visualisation more easily than the text, and be able to do it faster than reading text.

a. **Innate visual processing abilities:** A number of studies explain that humans have innate visualisation processing abilities. For example, Ungerleider and Haxby (1994) point out that visual processing is the most richly represented sensory modality in the human brain. Reading relies on the same visual areas, but requires additional processing and cognition, and is more resource-intensive.
b. **Superiority to text:** Bauer and Johnson-Laird (1993) carried out empirical studies and showed that visual representations were superior to verbal sequential representations when people carried out tasks. This suggests that the visual representation is easier for people to understand.
c. **Supports pattern recognition:** The basic rationale behind the visualisation of information is to provide a means for people to spot and identify patterns since humans are better than computers at identifying visual patterns (Ellis, 1938). Visualisations are innately superior to text in depicting boundaries, arranging and ordering concepts and therefore conceptual frameworks can only benefit from visualisation (Fisk, Scerbo & Kobylak, 1986; Mayer, 1989).
d. **Stronger memory trace:** There are superior memorial effects too: visual recall seems to be more reliable than verbal recall, which suggests that a visualisation should "stick" longer than verbal descriptions (Kosslyn, 1980)
e. **They provide an indication of how the producer sees the world:** Giullemin (2004) argues that drawings help people to depict how they make sense of a concept. She says that it allows the consumer to extract meaning in a way that is not constrained by the use of text. Kind (2004) found that when students were asked to depict their understanding of a concept in a drawing it was quickly clear which students did not understand the underlying concepts.

The producer can also benefit, by expressing themselves in a language-neutral format, by consolidating all their knowledge into one coherent unit.

a. **Ameliorating language difficulties:** Flower and Hayes (1980) say, "A writer in the act of discovery is hard at work searching memory, forming concepts, and forging a new structure of ideas, while at the same time trying to juggle all the constraints imposed by his or her purpose, audience, and language itself" (p. 21). If a writer is hampered by language limitations they are bound to find it difficult to express their ideas properly.
b. **Pictures are sometimes better than a description for depicting complex topics:** Andriessen, Kliphuis, McKenzie and Van Winkelen (2009) explain that pictures can actually capture more nuances of a complex subject than a textual description.
c. **Drawing helps to clarify ideas in the producer's mind:** Frankel (2005) explains that "thinking how to visually express an idea is also a means of clarifying the idea for the person making the drawing" (p. 155). He cautions that the production of the drawing must be for the purpose of communication; this adds the crucial extra dimension to the activity that consolidates the concepts in the person's mind.

This snapshot literature review demonstrates the benefits of visualisations in other contexts. The purpose of this research was to determine whether visualisation could be used in postgraduate reporting, in order to facilitate more effective assessment.

APPROPRIATENESS OF VISUALISATION IN DISSERTATION ASSESSMENT

The surveyed literature on assessment did not reveal any studies related to the explicit use of information or knowledge visualisation in postgraduate assessment. This apparent omission warrants further investigation in the light of the following facts about visualisation.

Visualisations could be useful in supporting dissertation assessment for two reasons. The first is that it helps the assessor by reducing the cognitive overload. The visualisation is a coherent unit, presented in a format that the human brain prefers to process. It is visually available and provides a launching pad into the dissertation as a whole.

The second reason is that it provides evidence of the student understanding and engagement as is often measured by mastering threshold concepts (Kiley & Wisker, 2009). Both new and adapted visualisations appear to provide evidence of a relatively deep level of mental processing. Consider the following two approaches to coming up with visualisation:

1. **Create it anew.** This requires the drawer to engage deeply with the subject matter and to come up with a way of visualising it (Chen et al. 2009). Rowe and Cooke, (1995) assessed people's mental models in a high technology workplace where a particular level of knowledge is essential to carry out tasks properly. They tested four different mechanisms and identified a strong relationship between the person's ability to produce a high quality diagram of a situation and their proven ability to troubleshoot a problem.
2. **Adapt it from, or extend, another researcher's visualisation.** Laseau (2000) argues that extending someone else's image also helps the learner to expand his/her thinking.

Both these actions suggest that a relatively deep level of mental processing is involved in creating visualisations.

METHODOLOGY

RESEARCH QUESTIONS

The meta-research question that motivated this study was: "How useful are visualisations in postgraduate assessment?" This broad investigation goal was translated into specific research questions:

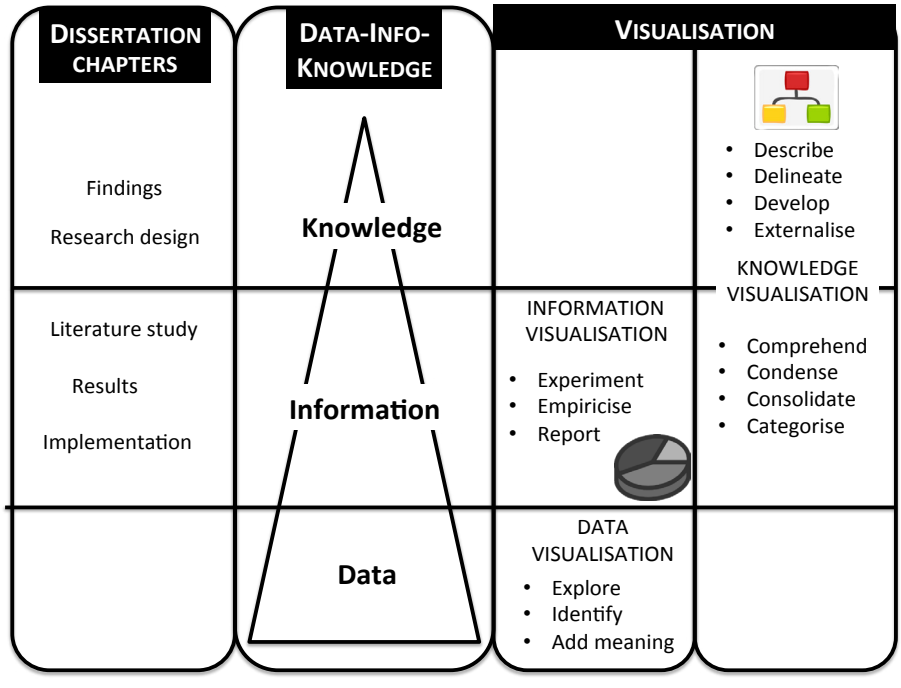
- How prevalent are visualisations in postgraduate dissertations (total number and position)?
- How are the visualisations distributed across the dissertations?
- Does the use of visualisation impact the final mark?
- What are supervisors' expectations, in terms of visualisation deployment, in dissertations?

RESEARCH CONTEXT

The postgraduate supervision capacity in the School of Computing has changed drastically due to rapidly increasing student numbers. In June 2010, there were 88 registered masters and doctoral students; in June 2011, there were 131; while in June and in November 2012, there were 197 and 226 students respectively. Over the same period, supervision capacity increased marginally, but nowhere near the more than double the student numbers since 2010 (Van Biljon & de Villiers 2013). Dissertations in Computing may include tables, diagrams and visual images of equipment or participants, but photos, since they are rarely used, were excluded from the analysis. It should be noted that knowledge visualisations (tables and figures) were not incentivised or explicitly rewarded at this institution. Furthermore, we could only evaluate masters' dissertations since we wanted to explore impact on final grade and doctoral studies are not awarded a final grade at this institution.

Figure 1 depicts the traditional constructs involved in information and knowledge visualisation, as discussed earlier. We also explain how different kinds of visualisations map onto the pyramid, in terms of their purpose. In the left column we suggest a likely spread of information and knowledge visualisation in a postgraduate dissertation.

FIGURE 1: MAPPING VISUALISATION TO CHAPTERS AND DATA-INFORMATION-KNOWLEDGE PYRAMID CONCEPTS



Source: Van Biljon & Renaud, 2015

RESEARCH APPROACH

The methodology entails a mixed-methods approach. This study extends the results of earlier work on visualisation (Van Biljon & Renaud, 2015) by revisiting the dissertation analysis and interviewing more supervisors. In this study 22 Master's dissertations in Computing from the University of South Africa were obtained through the university's official website. No permission is required to use the dissertations for academic purposes. Ethical clearance was obtained from the Research and Ethics Committee to access the students' marks, and also to regulate the interviews with the supervisors.

To answer the first question, namely *"How prevalent are visualisations in postgraduate dissertations (frequency)"*, the number of visualisations (figures and tables) in the dissertations were tallied. To answer the second question, relating to the distribution (positioning of the visualisation within the dissertations), the number of visualisations in the specific sections of the dissertations were tallied.

The section categorisation was based on the categorisations of evaluation report for Masters' dissertations in information systems from the University of Pretoria, the Tshwane University of Technology and the University of South Africa. Identified sections were: Introduction, Literature study, Research Design, Implementation, Results and Findings. (Note that the *Requirements* and *Implementation* chapters were not relevant to all research designs but *Implementation* was retained so as not to obscure the results in the other categories found in most dissertations.) The third question concerned the possible impact of visualisation usage on the final mark. To answer this question, the correlations between the total number of visualisations in each of the sections, and the final mark, were calculated.

The fourth question relates to the supervisor perspective with respect to the role of visualisation in dissertations. We interviewed 15 experienced supervisors and asked them to complete a short questionnaire which asked about their supervision experience, their expectations related to the use of visualisation by their students generally, and specifically on the role of visualisation during assessment.

RESULTS

DISSERTATION ANALYSIS

We analysed 22 dissertations in information systems (IS) (a sub-discipline of Computing). There were 10 male and 12 female students representing 73% of the masters' dissertations submitted to the institution in the 2002 to 2012 period.

There were no dissertations without figures and only two without tables. The sum, minimum and maximum number of figures and tables are given in Table 2. The dissertations averaged 29.64 figures and 18.59 tables.

TABLE 2: SUMMARY STATISTICS

	Figures	Tables	Total
Sum	652	409	1,061
Min	3		3
Average	29.64	18.59	48.23
Median	25.5	15.5	41.5
Max	87	48	120

The number of dissertations evaluated is too small for any analysis to deliver statistically significant results. However, it can be observed that visualisations were provided by all candidates and, indeed, used frequently in many cases. Figures were used more often than tables. Having ascertained that visualisations were indeed used, the next step was to consider which sections they appeared in. The distribution of the 1,061 visualisations across the 22 dissertations is shown in Figure 2.

FIGURE 2: SPREAD OF VISUALISATIONS ACROSS THE DISSERTATIONS

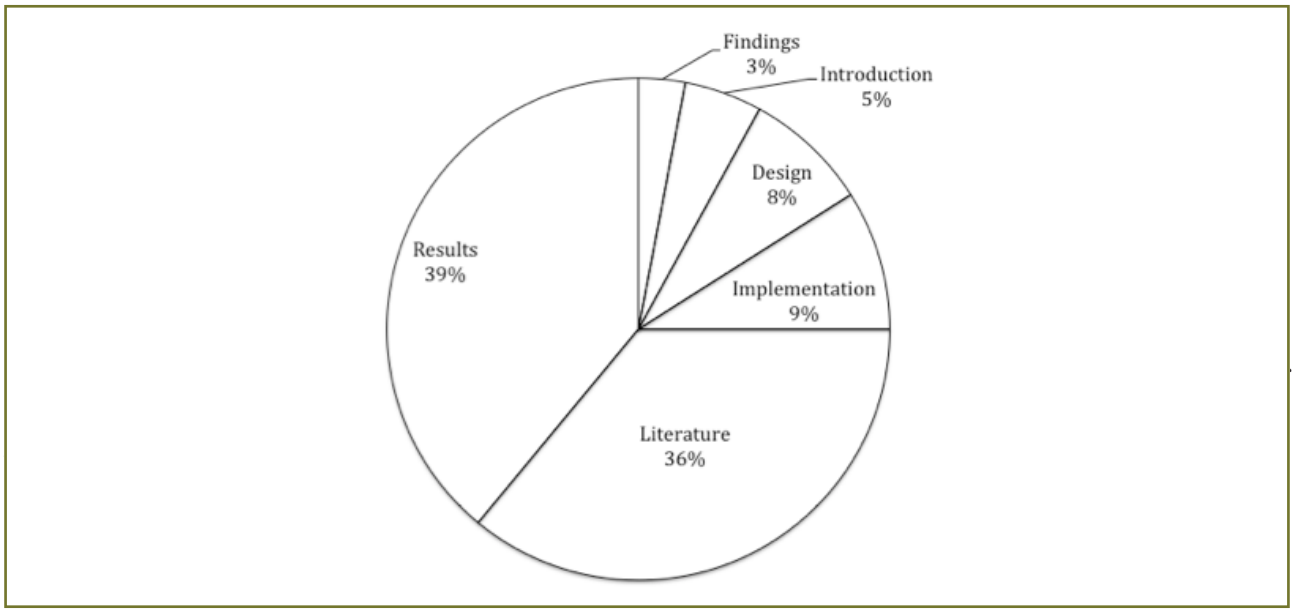


Table 3 shows the correlations between the final grade and the number of visualisations in the relevant chapters. The negative correlation of -0.107 between the total visualisation count and the students' final marks suggests that gratuitous use of visualisation could detract from the perceived value thereof, as judged by the final assigned grade. Moreover, depictions of existing diagrams, (-0.238), often found in the literature review, or information visualisation, as found in the results section (-0.08), do not seem to impact the final mark to any great extent. However, the number of visualisations in the research design and findings sections correlates modestly with the final mark. This may imply that knowledge visualisation was more useful and meaningful to examiners when they appeared in these chapters. It is possible that the examiners subconsciously used these as evidence of mastery or knowledge contribution.

TABLE 3: CORRELATIONS BETWEEN FINAL MARK AND VISUALISATIONS IN DIFFERENT SECTIONS

	Visualisation (total)	Literature review	Research design	Results	Findings
Mark	-0.107	-0.238	0.38	-0.08	0.40

Given the small sample of 22, we can only identify these trends as a topic for confirmation or rejection through further investigation. Figures 3 and 4 depict, using a bubble diagram, the correlations between the candidate's final mark and the visualisations in a specific section of the dissertation. The figures thus depict a 3-tuple space (Final mark, Total visualisation, Number of visualisations in section). The graphs plot the final marks of the students against the total number of visualisations in their dissertations for the specific section. The number within the bubble depicts the number of visualisations in the Results Section, in Figure III, and the number within the Findings section, in Figure IV. The colour of the bubble varies according to the number of visualisations in the applicable section of the dissertation, the darker the colour the higher the number of visualisations.

Note that the negative correlations (Literature Overview and Results sections), as depicted in Table 3, occurred where the visualisations were information visualisations or a mixture of information and knowledge visualisations. Figure 3 depicts the individual dissertation's visualisation in the Results section. The positive correlations occurred where the visualisations were mostly knowledge visualisations appearing in the Findings section, as shown in Figure 4.

FIGURE 3: FINAL MARK VERSUS TOTAL VISUALISATION. BUBBLE DEPICTING VISUALISATIONS IN THE *RESULTS* SECTION. (THESE ARE MOSTLY *INFORMATION* VISUALISATIONS).

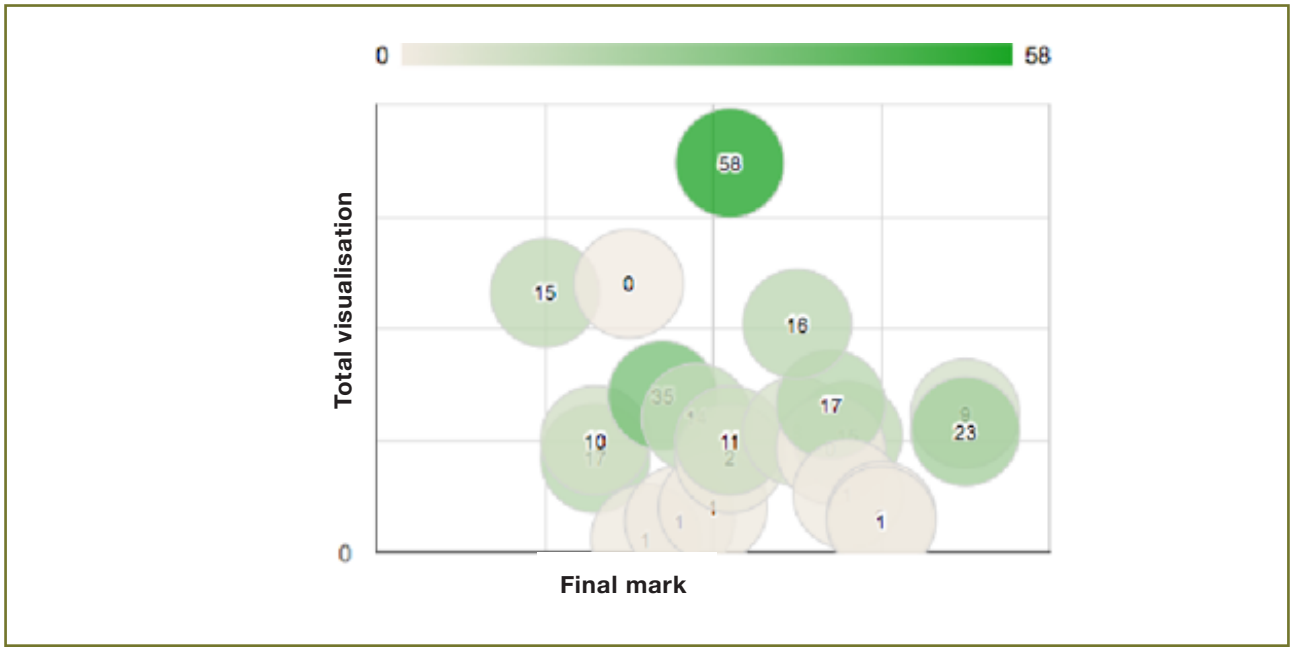
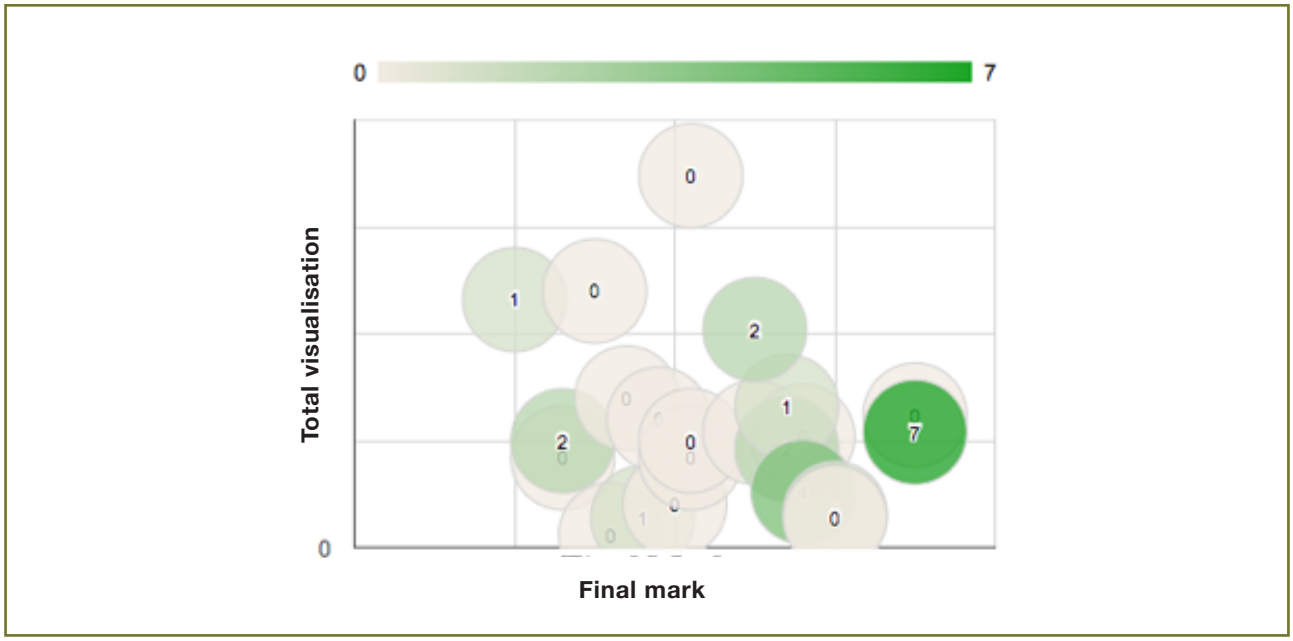


FIGURE 4: FINAL MARK VERSUS TOTAL VISUALISATION. BUBBLE DEPICTING VISUALISATIONS IN THE *FINDINGS* SECTION. (THESE ARE *KNOWLEDGE* VISUALISATIONS)



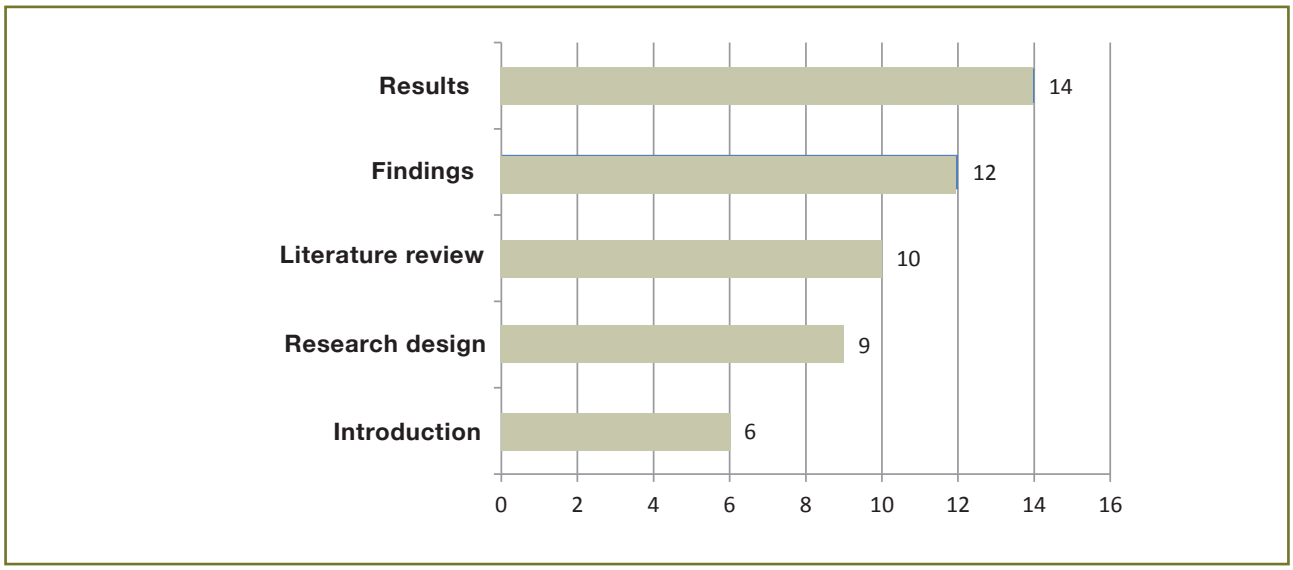
Visualisations in the Research design section resonate with the use of conceptual frameworks in postgraduate dissertations as advocated by Leshem and Trafford (2007). Kiley and Whisker (2009) introduced the idea of generic doctoral-level threshold concepts to provide a framework for research learning and teaching at graduate level. The practice of constructing a conceptual framework is, first and foremost, for the student's benefit. It seems as if structuring and sense-making of the abstract and theoretical process in terms of a conceptual framework that can be visualised is generally rewarded in the final mark. The same argument might explain the positive correlation between the Findings section and the final mark. In the next section we consider the supervisors' views on the deployment of visualisation in masters' dissertations.

FEEDBACK FROM SUPERVISORS

All 15 interviewees had supervised masters' students to completion and examined masters' dissertations (half had supervised more than five students to completion). The participants all encouraged their students to use visualisations. Eleven always did so, one often and two sometimes, and one responded with "rarely" (no-one answered "never").

When asked if they appreciated the presence of knowledge visualisations when assessing dissertations, 13 interviewees answered "yes" and two interviewees responded with "sometimes". This indicated a discrepancy between their expectations and the instructions given to the students, i.e., not all of those supervisors who appreciate visualisations when assessing actively encourage their students to produce visualisations. Figure 5 depicts the number of supervisors (out of a total of 15) who would encourage visualisations in the given dissertation section.

FIGURE 5: THE PARTS OF THE DISSERTATION WHERE SUPERVISORS(SAMPLE OF 15 INTERVIEWEES) ENCOURAGED VISUALISATION



The supervisors were asked to explain the motivation for having visualisations in the different sections. We explained that the research was focused on masters' dissertations but the supervisors did not express a need to differentiate between the visualisation requirements and expectations for masters' and doctoral students. Supervisor comments were as follows:

- **Introduction and overview** (six supervisors encouraged visualisations): "To provide an overview of the anticipated structure; to indicate the sequence of events, for example a thesis map or chapters' map; to show interrelationships".
- **Literature review** (10 supervisors encouraged visualisations): "To provide an overview of essential concepts; outline and scope the literary environment; to summarise the literature and demonstrate the connection of theories; as a summary to compare themes and show patterns; a timeline for theory development".
- **Research Design** (nine supervisors encouraged visualisations): "To show the research process, research flow and how the different terms (epistemology, theoretical framework, methodology and methods) are interrelated, to depict triangulation".
- **Presentation of results** (14 supervisorsencouraged visualisations): "Use in summarising results. charts and graphs where appropriate and other forms such as time lines, networks with indications of relationships".
- **Presentation of findings** (12 supervisors encouraged visualisations): "Summation of findings; used for 'sense making' in communicating with the reader; results and findings especially in quantitative studies; building or confirming a model; and checking the logical flow from the research design to the findings".

Regarding the *Literature Review* section, where two-thirds of the examiners expected visualisations: visualisations placed there could be very useful to the examiner. For example, the student performs a literature review, which mines the relevant research literature. The writer of each of the sources contributed new knowledge to the field but to this particular student this is information, to be understood, consolidated, synthesised and presented in a coherent format. A good master's student may well produce new knowledge in this chapter, perhaps in the form of taxonomy or a consolidation from a novel perspective, but that is unusual and certainly not expected. Interestingly, the dissertation analysis yielded a negative correlation between the number of visualisations in the literature review and the final mark. It could be because the visualisations included here often replicate other researcher's visualisations – a practice not recommended by the supervisors.

All but one of the interviewees expected to see visualisations in the *results* section, which concurs with the distribution we observed in Figure 2, but not with the negative correlations between visualisations and the Results section as depicted in Table 3. The explanation might be that the results are not yet knowledge: they represent *information* that needs to be conceptualised and reflected upon. Visualisation thereof, perhaps in the form of a graph accompanied by an interpretation, could constitute knowledge, and this is usually reported in the findings chapter. The majority of respondents expected visualisations in the findings chapters; this concurs with the positive correlations between the

visualisations in those sections and the final mark (see Table 3). The analysis of the dissertation revealed a relatively low number of actual visualisations in the Findings chapter (Figure 2) and this could be of interest to supervisors.

It can be concluded that the visualisations in the introduction and conclusion sections constitute *"good practice"* as far as writing scientific reports is concerned, but one does not expect to see new knowledge reported in either of these chapters – only a summary or a précis thereof. Knowledge is presented within the body of the dissertation and that explains the relatively low number (40%) expecting visualisations in the "Introduction" section.

Finally there is the negative correlation between visualisations and the final mark, as depicted in Table 3. Could it be that the quality of the visualisations was not acceptable, did the visualisations demonstrate the student's lack of understanding, or could it be that the students used visualisations instead of text, or replicated other authors' visualisations? There could be a number of explanations and without explicitly investigating each case it is difficult to rule one way or another.

Besides the effort involved for the student, there seems to be little argument against including visualisations as a mechanism of knowledge representation in postgraduate dissertations. A further investigation using a bigger sample to conduct a deeper investigation into expectations related to the use of visualisations, and the other factors that could influence this correlation, is required.

DISCUSSION

This research addressed three questions, namely *"How prevalent are visualisations in examined dissertations?"*, *"In which parts of the dissertation are they situated?"*, and *"Does their use have any impact on the student's mark?"*.. In response to the first question, related to the prevalence of visualisation, we can confirm that visualisations, in terms of figures and tables, were often used, with a preference for figures. Visualisations were not explicitly required or assessed by this institution and no information was provided on how visualisations should be crafted. The prevalent use of visualisations, despite the lack of incentive or regulation, might provide evidence for an inherent appreciation of the value of dissertations. The discrepancy between appreciating visualisations and encouraging students to produce them further supports the need to investigate the deliberate use of visualisations in dissertation assessment.

The second research question was related to the distribution of the visualisations across the dissertations, and there we found that the visualisations were mostly found in the literature and results sections. Regarding the potential impact we found that the candidate's final mark was correlated, albeit weakly, to the particular section where visualisations appeared. A positive correlation was observed between the final mark and the number of visualisations in the research design and findings chapters. Given the small number of dissertations we analysed and the many other factors that can influence the final mark, we cannot claim causation. This finding does, however, motivate further investigation. In speculating on possible explanations for this correlation we consider a number of aspects.

The first is that the assessor was subconsciously rewarding knowledge visualisations appearing in the research design and findings sections. If this were the case it could be that such visualisations make it clear to the assessor what knowledge was being reported, without first having to read through pages of text. The visualisation could be providing a précis, a quick and powerful overview of the text. If this is true, the assessor gets an informative aid, something that allows them very easily to get a sense of what is being reported.

The second possible explanation could be that the visualisations are evidence that the student has indeed mastered the material. In crafting the visualisations, the students reach a deeper level of understanding of the topic area, and this was reflected in the quality of the whole report. If this were true, the quality was a side-effect, a consequence of their delivering the visualisations. As noted before, there is the argument that learning styles are based on individual modal divisions i.e., the visual, kinesthetic and aural (Fleming, 1995), which may well impact on the learning facilitated by visualisations. However, whether the visualisation is a medium or an artifact, there does seem to be a positive impact of the students spending time crafting and including one or more knowledge visualisations in their dissertations.

There is clearly a proviso: that visualisations should be used with care. If used appropriately, they can impact the mark positively, but mindless inclusion of visualisations could depress the final mark. The challenges pertain to the type of visualisation, as well as the distribution. Regarding the types of visualisation, we observed that many were mere reproductions that added no value except, perhaps, the aesthetic. The negative correlation (albeit small) – between the total number of visualisations and the mark – could confirm the argument that the mere presence of visualisations does not automatically improve the candidate's final grade: it has to be done thoughtfully and constitute a meaningful artifact that supports assessment.

In summary, we conclude that given the innate human ability to understand and remember visual representations, the considered inclusion of visualisations could support objectivity, consistency and fairness in assessment. It could also help students to engage in more depth with the subject matter, reaching a profounder understanding thereof, in the process of producing the visualisations. In practice this means that we should consider instructing candidates to include specific standard visualisations such as a chapter map, a literature overview diagram and a visualisation of their conceptual framework. This could support efficient assessment by allowing triangulation with the traditional

text-based assessment. The use of visualisation admittedly poses risks. The risks could be both designer and user induced and relate to cognitive, emotional and social human aspects (Bresciani & Eppler 2009). Hence the promotion of the use of visualisation in research reporting should be based on validated guidelines and standards. Kelleher and Wagener (2011) provide useful guidelines for effective data visualisation in scientific publications, but those guidelines need to be refined and customised for dissertation knowledge transfer. Furthermore, visualisations are proposed as a mechanism to complement other assessment criteria, never as the sole assessment artifact.

Finally, the fact that the surveyed examiners recommended the use of visualisations to their own students, and expected to see them in the dissertations they examined, seems to suggest that visualisations are already making their way into dissertations. At the moment, their use seems to be dependent on the whim and preference of the supervisor and the student. If, as we believe, visualisations can be helpful to both students and examiners, it is necessary for us to formalise their inclusion and provide more guidance to all students to support their production and effectual use.

LIMITATIONS

The use of visualisation needs to be guided by some assumptions and delineations. Machanick (2014) warns that imposing technology between the teacher and the students can create a barrier, and that is a real concern in the use of visualisations. Therefore it has to be acknowledged that the intended focus of a visualisation is the cognitive activity of representing knowledge while the technology is merely the tool and should not be given overdue attention or used for obfuscation.

CONCLUSION

Despite the potential of visualisations for improving knowledge transfer, there is little evidence of the deliberate use of visualisations to improve the efficiency of assessment. We considered the extant use and potential usefulness of visualisations in postgraduate assessment. We conclude that the use of visualisations in adding value for: (1) the student, (2) the examiner and (3) influencing the final mark, warrants further investigation. Arguably the appropriateness of visualisation usage may be related to the subject area, but the general benefits of visualisations in knowledge generation and transfer are not related to a specific subject area. No comprehensive guidelines seem to exist on the appropriate use of information and knowledge visualisations in postgraduate dissertations. If these can be produced to the satisfaction of the assessors then visualisation could well be an efficacious assessment and learning aid. The choice to use visualisations should remain the prerogative of the student, in consultation with the supervisor. This decision should be taken against the background of having usable guidelines, together with evidence-based awareness of the potential of visualisations to relieve assessment pressure. This is the discourse we would like to propose for further debate. As future work, we should consider how to provide guidance on standardising the expectations and assessment of visualisations in postgraduate dissertations, as well as the provision of guidance for students in the production of "good" visualisations in this context.

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ATTRIBUTES CONTRIBUTING TO STUDENTS' USE OF QUALITY SOFTWARE DEVELOPMENT PRACTICES

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ABSTRACT
In 2001 the "McCracken group", through a multi-institutional study, concluded that many students finishing their introductory programming courses could not program due to a lack of problem solving skills. In 2004 Lister established that students have a fragile grasp of skills to read and interpret code. Humphrey suggests that educators must shift their focus from the programs that the students create to the data of the processes the students use. This paper addresses the problem of poor performing students through an investigation of their quality appraisal techniques (QATs) and development processes. Firstly, a survey was conducted to determine the current software development practices used by a group of undergraduate Computer Science students. Numeric data collected revealed that the current practices used by the majority of students would not be sufficient to produce quality programs. Secondly, a case study was conducted to gain a deeper understanding of the various factors that are likely to influence students' intention to use QATs. Analysis of numeric data collected through a survey revealed that students' intentions to use QATs are driven by ease of use, compatibility, usefulness, result demonstrability, subjective norm and career consequences. Thirdly, an experiment was conducted to determine students' perceptions on the use of process measurement data to improve their current software development practices. Analysis of numeric and narrative data revealed that performance measurement data could provide students with useful information to adopt proper development practices.

KEYWORDS
problem solving, software development process, quality appraisal techniques, personal software process, undergraduate education

INTRODUCTION
Despite all the efforts of Computer Science educators to train students to develop software programs of the highest standard, the programming performance of undergraduate students is often worse than expected. This can be attributed to the lack of problem solving skills (McCraken et al., 2001), as well as poor code reading and interpretation skills (Lister et al., 2004). Humphrey (1994; 1999) created the Personal Software Process (PSP) that guides software developers in the use of process measurement and quality appraisal techniques (QATs) (in the form of personal design reviews and code reviews) to improve the quality of their programs. He suggests that educators must shift their focus from the programs that the students create to the data of the processes the students use (Humphrey, 1999). Various researchers reported on their experiences with the incorporation of PSP in educational environments (Börsteler et al., 2002; Jenkins & Ademoye, 2012; Towhidnejad & Salimi, 1996; Williams, 1997).

The aim of this paper is threefold:

1. To discover which QATs and software development practices are used by undergraduate Computer Science students at a selected South African University of Technology.
2. To identify factors that influence students' intent to use QATs.
3. To investigate the role of process measurement data as a contributor to the use of quality software development practices.

LITERATURE REVIEW
In 2001 the "McCracken group" (McCraken et al., 2001) conducted a multi-national, multi-institutional study in the United States of America (US) and other countries during which they assessed the programming competency of Computer Science students who completed their first or second programming courses. They found that the majority of the students' programming performance was much worse than expected. Students indicated "the lack of time to complete the exercise" (McCraken et al., 2001, p. 133) as the major reason for poor performance. The research group also found that students struggle to abstract the problem from the exercise description (McCraken et al., 2001) and therefore lack the ability to do problem solving. The group argues that students might have inappropriate (bad) programming habits because they treat program code as text and simply try to fix syntax instead of focusing on the task that the code must accomplish. They suggest that future research should analyse narrative data gathered from students to gain better insight into the students' development processes and problem-solving behaviour.

Lister et al., (2004) conducted a follow-up study on the McCracken group's research to investigate alternative reasons for poor programming performance. Their findings indicate that many students have "a fragile grasp of both basic programming principles and the ability to systematically carry out routine programming tasks, such as tracing (or 'desk checking') through code" (Lister et al., 2004, p. 119). According to Perkins, Hancock, Hobbs, Martin and Simmons (1989), students' code reading and interpretation skills can be linked to their ability to review and debug code.

Software quality can be defined as software that conforms to the user requirements (Crosby, 1979). Software review methods are widely used in the industry to improve the quality of software programs (Fagan, 1976; Schach, 2011), as testing alone is seen as a very ineffective and time-consuming debugging strategy (Schach, 2011). According to Humphrey (2005), effective defect management is essential in order to manage cost and schedule during software development and also contributes to software quality. Humphrey states that testing alone is not the most effective way to remove defects. He proposes the inclusion of additional quality appraisal techniques such as inspections, walkthroughs and personal reviews. An inspection is a kind of structured team peer review process that was introduced by Mike Fagan (1976). Walkthroughs are less formal, with fewer steps than inspections (Schach, 2011). Fagan (1976) concludes that a developer's productivity increases when he uses inspections because less time is spent on unit testing. Schach (2011) indicates the advantages in time, cost and essentially project success when defects are discovered early in the development life cycle.

Humphrey (2005) regards inspections and walkthroughs as team quality techniques. He proposes that individual software developers should review their work before peer inspection, hence the term "personal reviews". He indicates that, despite all the literature that guides software developers on "good" practices and effective methods, the only generally accepted short-term priority for a software developer is "coding and testing".

Humphrey (1999) claims that one of the biggest challenges in software development is to persuade software developers to use effective methods. Software developers tend to stick to a personal process that they develop from the first small program they have written, and it is difficult to convince them to adopt better practices. Humphrey (2005) created a PSP course in which a software developer gradually learns to adopt his/her software practices according to personal measurements. The aim of the course is to improve program quality through personal reviews and to enable a software developer to make more accurate estimations based on personal historical performance data (collected by the individual). Analyses of thousands of PSP students' measurement data indicate that personal reviews improve program quality and that students spent less time in the testing phase if they use quality appraisal techniques (design reviews and code reviews). The course data also indicates an improvement on predictions based on historical data. Humphrey (1999) states that PSP trained students in an educational environment will only use these methods if the educator grades them on the use thereof, and that most students eventually will fall back on a process of coding and testing. He suggests that Computer Science educators must shift their focus from the programs that the students create to the data of the processes the students use. A number of researchers reported on their experiences with the incorporation of personal software process techniques in educational environments.

Jenkins and Ademoye (2012) conducted a pilot and follow-up experiment in which students used personal code reviews to improve the quality of their individual programs. Although there is no concrete evidence to support this statement, the narrative feedback from the students in both experiments indicate that they believe the process of using code reviews improved the quality of their programs.

Towhidnejad and Salimi (1996) incorporated a simplified version of PSP as part of two first-year Computer Science courses. They report that PSP helped students to improve their time management and time estimations, as well as to decrease the number of syntax defects. Students only accepted PSP as an integral part of their development practices in their second semester of PSP usage. The educators' biggest challenges were (1) to motivate students to follow the PSP defined process and (2) to get students to collect accurate and reliable data.

In an attempt to train better software developers the University of Utah incorporated PSP concepts in all their undergraduate Computer Science courses. Williams (1997) reports that although students demonstrated accurate theoretical knowledge of PSP principles, they struggled with the application thereof. He remarks that discussion of group statistical feedback data might influence students' intention to capture more accurate individual process measurements. His biggest challenge was to motivate students to use PSP as part of their natural program development practices.

Börsteler et al., (2002) report on their experiences of teaching some PSP variations at different universities. At Montana Tech, University of Montana, students showed initial resistance to PSP but the general reaction at the end of the course was that they felt "more aware of their programming practices and shortcomings" (p. 45). Although some master's students at Drexel University also showed initial resistance to PSP several of them reported incorporating at least some PSP parts in their work environments. An evaluation of Purdue University students' attitude towards PSP reveals that they regarded PSP activities as "extra work" (p. 45) and did not show appreciation for the potential benefits of this disciplined process. Students strongly recommended that PSP topics should rather be placed in later programming courses when students are already familiar with language-specific syntax and development environment. At Umeå University the use of PSP was optional in a second year C++ course, with only six of 78 students opting to use it throughout the course. The students' main reason for abandoning PSP was that it "impose[d] an excessively strict process on them" (p. 44) and that they did not believe that the extra effort was worthwhile.

In an attempt to test the process improvement claims of PSP, Prechelt and Unger (2000) conducted an experiment to compare the performance of PSP-trained programmers (P-group) and non-PSP trained programmers (N-group). They report that 18 of the 24 P-group participants did not use PSP techniques at all. Prechelt and Unger (2000) claim that the low level of PSP usage might be explained by the "different temperaments of the programmers", the small size of the PSP tasks as well as the absence of "a working environment which actively encourages PSP usage" (p. 471). They call for further investigations into the technical, social and organisational attributes (beyond the level of training and infrastructure provided) that might influence the use of PSP methods.

METHODOLOGY

This research study followed a mixed methods approach based on the Framework of Integrated Methodologies (FraIM) as suggested by Plowright (2011). The context of this study was the Information Technology department at a selected South African University of Technology. The study was divided into three cases in order to distinguish between the three main sources of data (Plowright, 2011).

CASE 1 METHODOLOGY

In Case 1 a survey (Plowright, 2011) was conducted to gather information regarding undergraduate Computer Science students' perceptions of the quality appraisal techniques and software development processes they normally use when developing programs. The research population for this case included all first, second and third year Computer Science students at the selected institution. Data was collected by means of "asking questions" in a paper-based self-completion survey containing closed questions (Plowright, 2011). The survey was distributed and completed during normal lectures. A total of 251 students (the sample) completed the survey. This sample included 74 first-year, 113 second-year and 64 third-year students. The numerical data collected through the survey was analysed in MS Excel and the results grouped according to the year level of the respondents.

CASE 2 METHODOLOGY

In Case 2 a case study (Plowright, 2011) was conducted to gain a deeper understanding of the various factors that are likely to influence students' intention to use QATs. The research population for this case was restricted to fourth-year Computer Science students from the selected institution, who were registered for the Software Engineering module (55 students). These students were selected because they were already familiar with the various techniques that can be used to improve the quality of their programs. Data was collected by means of "asking questions" in a paper-based self-completion survey (Plowright, 2011). The survey was distributed and completed at the end of a scheduled lecture. Forty-seven students (the sample) completed the survey (85% response rate).

There are numerous theoretical models that can be used to examine individual intentions to adopt information technology tools. Although software development methodologies and more specifically QATs cannot necessarily be regarded as technological tools, a study conducted by Riemenschneider, Hardgrave and Davis (2002) provides empirical evidence that established models of individual intentions for tool adoption can be used to provide insights into methodology adoption by software developers in a large organisation. For their study, Riemenschneider et al., (2002) selected the following existing technology acceptance models:

- Technology Acceptance Model (TAM) (Davis, 1989);
- TAM2 (Venkatesh & Davis, 2000);
- Perceived Characteristics of Innovating (PCI) (Moore & Benbasat, 1991);
- Theory of Planned Behaviour (TPB) (Ajzen, 1985); and
- Model of Personal Computer Utilisation (MPCU) (Thompson, Higgins & Howell, 1991).

After evaluation of these five models Riemenschneider et al., (2002, p.1139) identified 12 constructs (which include both common and unique constructs from the selected models) as appropriate in the context of methodology adoption. The selected constructs are defined as follows in the context of Case 2:

- **Behavioural intention (BI)** – the extent of the student's intention to use QATs.
- **Usefulness (U)** – the extent to which the student thinks that using QATs will enhance his/her programming performance.
- **Ease of use (EOU)** – the extent to which the student perceives that using QATs will be free of effort.
- **Subjective norm (SN)** – the extent to which the student thinks that others, who are important to him/her, think he/she should use QATs.
- **Voluntariness (VOL)** – the extent to which the student perceives the adoption of QATs as non-mandatory.
- **Compatibility (C)** – the extent to which QATs are perceived as being consistent/compatible (incorporable) with the current manner in which the student develops systems.
- **Result demonstrability (RD)** – the extent to which the results or benefits of using QATs are apparent to the student.
- **Image (IMG)** – the extent to which the use of QATs is perceived to enhance the student's image/status in his/her social system.
- **Visibility (VIS)** – the extent to which the use of QATs can be observed in the student's learning environment.
- **Perceived behavioural control – internal (PBC-I)** – the student's perceptions of internal constraints on using QATs.

- **Perceived behavioural control – external (PBC-E)** – the student's perceptions of external constraints on using QATs.
- **Career consequences (CC)** – the extent to which the adoption of QATs will influence the student's chance to secure employment after completing his/her degree.

The survey constructed for Case 2 was based on the validated measurement scales from Riemenschneider et al.'s (2002) research study, with rewording of a number of items to make it relevant in terms of the context of Case 2. Each item was based on a 4-point Likert scale (1 = strongly disagree and 4 = strongly agree). The numerical data collected through the survey was analysed using SPSS software.

CASE 3 METHODOLOGY

In Case 3 an experiment (Plowright, 2011) was conducted to gain a deeper understanding of students' development processes through the collection of actual process data. The population for this case included all third year Computer Science students at the selected institution. These students were selected since they already had intermediate programming skills and experience in software defect removal strategies. From this population six students were randomly selected to participate in the practical experiment. Data collection included observations, asking questions (post-activity survey and interviews) as well as artefact analysis (Process Dashboard© data and program code) (Plowright, 2011).

The Case 3 experiment consisted of four steps as summarised in Table 1. The instructor first conducted a tutorial activity to teach students how to log and interpret performance-measurement data using the Process Dashboard© software. During this tutorial students were required to do an exercise in which they had to log time, size and defect measurements in different phases of the software development life cycle. The various defect types and examples of defects categorised into types were also discussed. After the tutorial the students completed an individual programming exercise during which they had to capture performance data using the Process Dashboard© software. For this programming exercise the students had to implement the code to simulate the "Quick Pick" option of the South African National Lottery (LOTTO©) draw.[1]

TABLE 1: EXPERIMENT DESIGN

Activity	Duration	Rationale
1. Instructor presents performance measurement tutorial.	1 hour	Teach students to do process measures and interpret process data.
2. Students do programming exercise. while Instructor makes observations.	3 hours	Capture process measures while doing programming exercise (student). Record student behaviour and questions asked (instructor).
3. Students complete post-activity survey.	15-20 min	Explore students' perceptions of process measuring.
4. Instructor conducts interviews with students	10 min (per student)	Gain deeper insights into students' development processes.

The students received an extensive background document on how "LOTTO" draws work. In the "Quick Pick" option a user of the system first had to select the number of player lotto draw records that should be generated. The requested number of records then had to be generated randomly, sorted and written to a text file. Each draw record had to contain the draw date, draw number (starting from 1) and seven unique numbers ranging from 1 to 49 (the six lotto numbers in ascending order followed by a bonus number). Students could use any resources, including the Internet, to complete this activity. While the students worked on the individual programming exercise the instructor moved around the students and recorded his observations as well as all questions from the students. After this exercise the students had to complete a post-activity survey that consisted of mostly open-ended questions. The purpose of this survey was to explore the students' perceptions on the capturing and interpreting of process-measurement data. In the final activity of Case 3 the instructor conducted interviews with all six students. During these interviews open-ended questions were used to gather narrative data regarding the students' development processes.

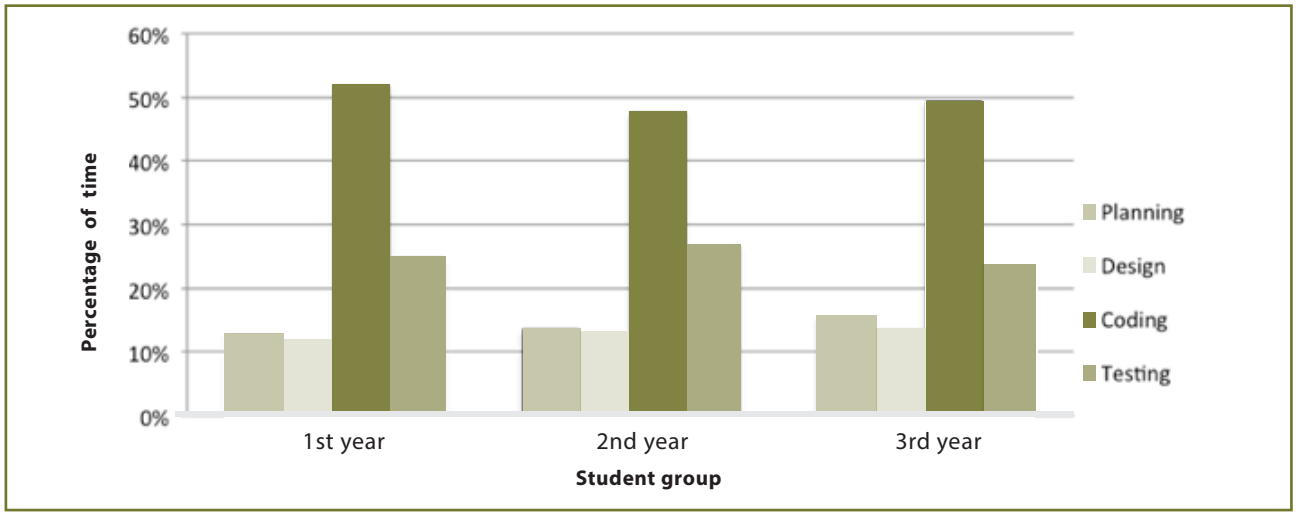
DISCUSSION OF RESULTS

CASE 1: PRE-SURVEY

Students first had to indicate how much of their development time is spent in each of the provided phases (see Figure 1). On average, students spent 25% of their development time on planning and design. They also indicated that most of their development time is spent on coding and contributes to 50% of the total development time. They spent 25% of their time on testing and debugging, which is roughly half the time that they spent on coding. Students of all year levels indicated almost similar results, which is an indication that a first year student and a third year student make use of similar development practices. It should be noted that the reported times are mostly estimates (individual perceptions) since only 16% of the students indicated that they record the actual time that they spend in the different development phases. The majority (88%) of students indicated that they do not use any time estimation techniques.

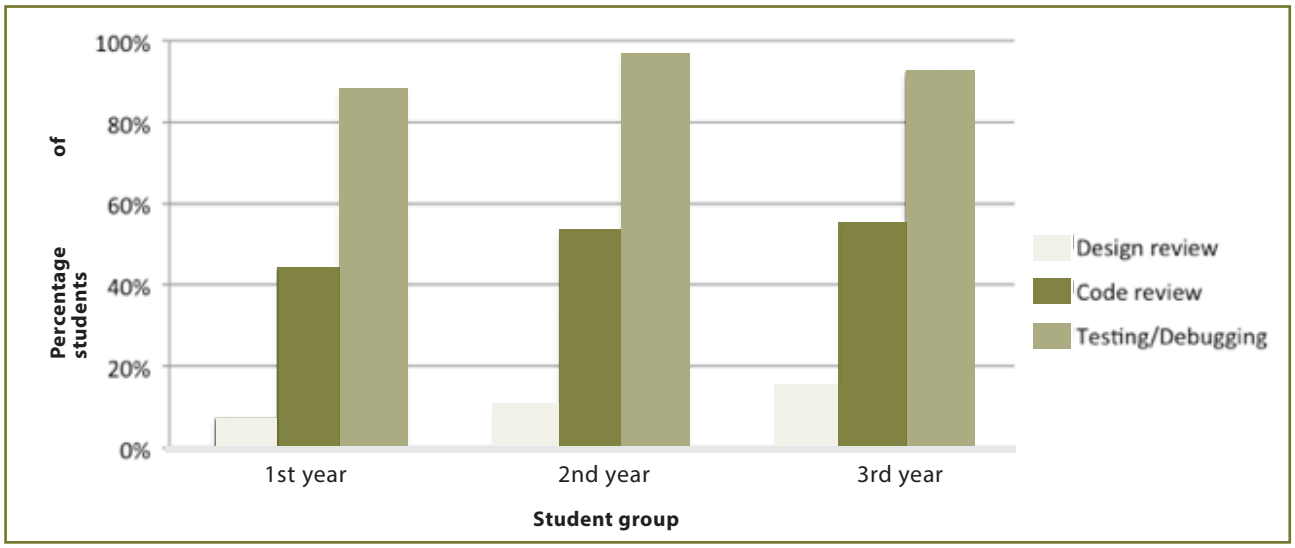
1 https://www.nationallottery.co.za

FIGURE 1: ESTIMATED TIME SPENT IN DEVELOPMENT PHASES



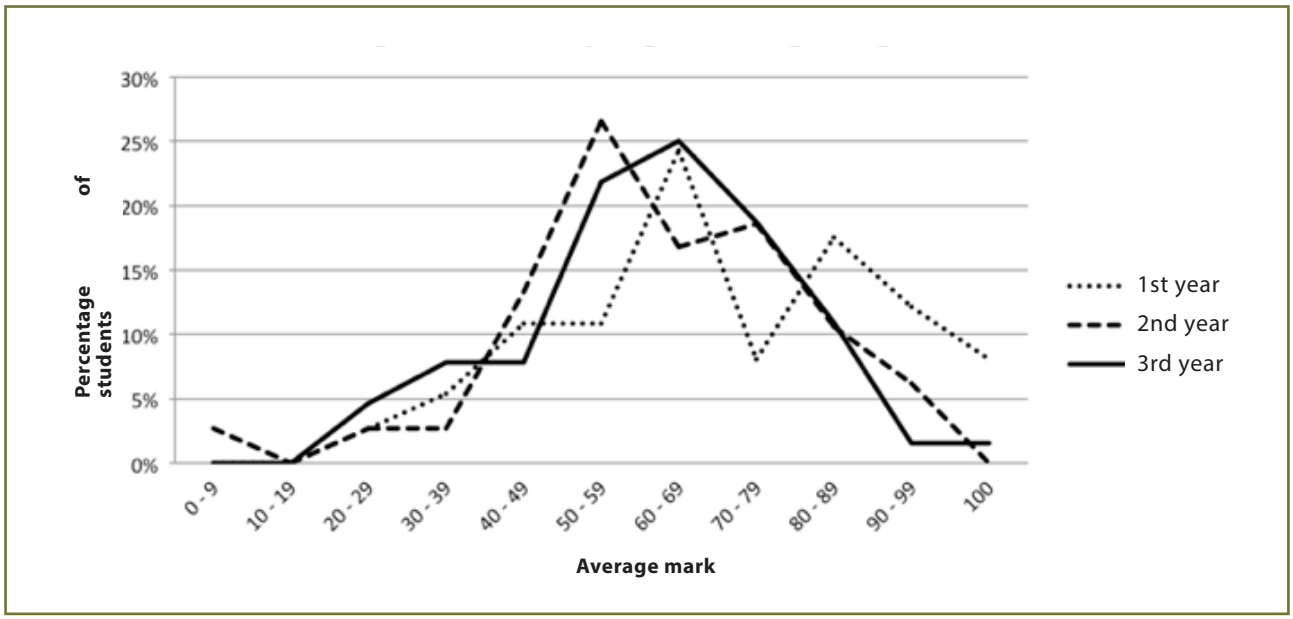
The next section of the survey focused on defect removal strategies. Students reported that they primarily use debugging for fixing defects as opposed to design and code reviews (see Figure 2). The use of design and code reviews increment slightly (10%) from first- to third-year students. Only 30% of the students indicated that they keep record of the defects they make.

FIGURE 2: USE OF DEFECT REMOVAL STRATEGIES



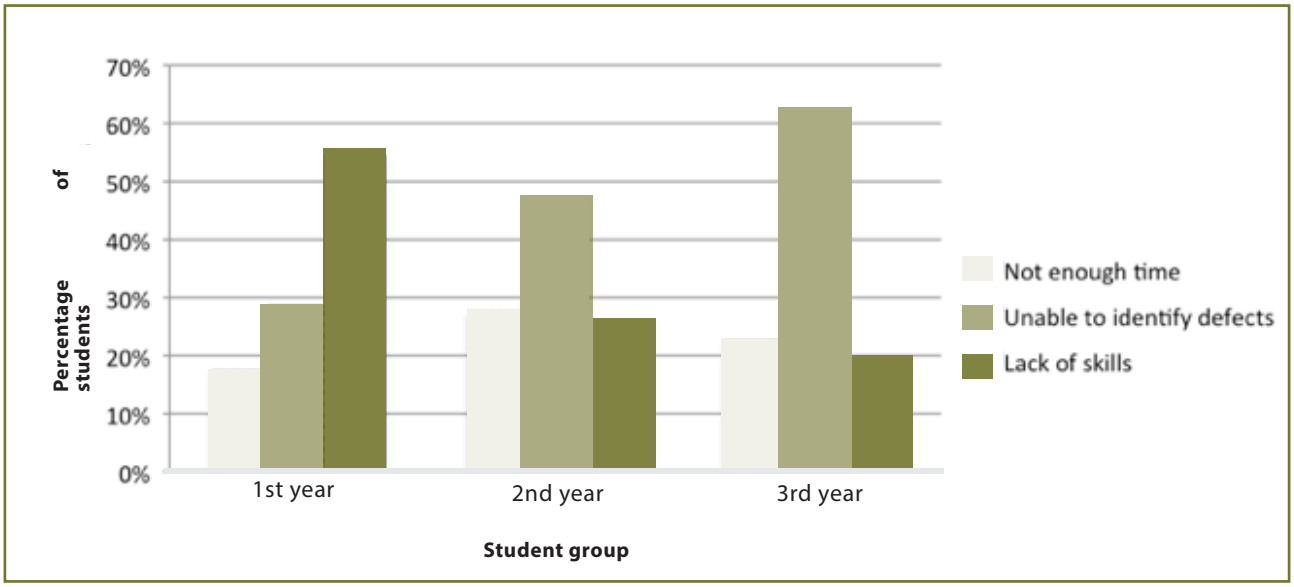
Students were also asked to give an indication of the average mark they obtain for their programming assignments. As indicated in Figure 3 the reported average marks form a normal distribution curve around 59.5%.

FIGURE 3: AVERAGE MARKS FOR PROGRAMMING ASSIGNMENTS



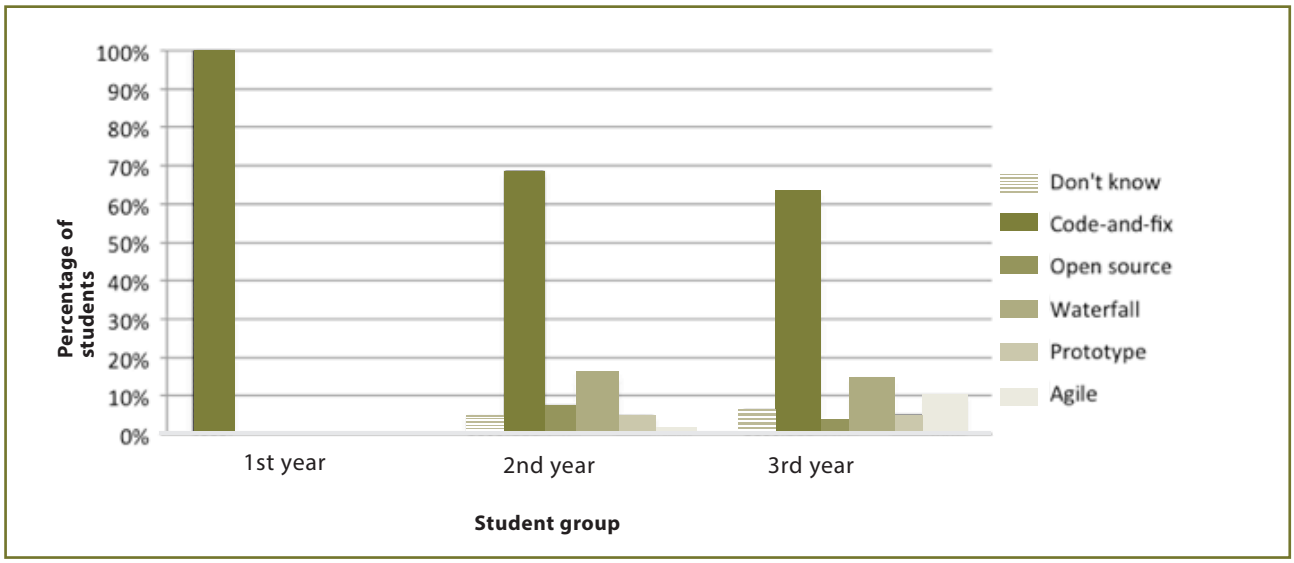
Students then had to select (from three provided options) the main reason why they do not score full marks in all their programming assignments. The data analysis revealed distinct differences between the responses from students in the different year levels (see Figure 4). The majority of first-year students (54%) believe that their lack of programming skills is the major cause of poor results. Second-year (47%) and third-year (62%) students mostly put the blame on their inability to identify defects. Towards the third year fewer students (16%) regard their "lack of skill" as the major reason for failure. Although the students in all year levels regard "time" as a stumbling block to their success it is not seen as the major contributor (with values ranging between 17% and 27%).

FIGURE 4: MAIN REASON FOR NOT SCORING 100% FOR ASSIGNMENTS



When students were asked to indicate their preferred software development life-cycle model the majority of second-year (68%) and third-year (63%) students selected "code-and-fix" (see Figure 5). It is not surprising that all the first year students selected the "don't know" option, since the first Software Engineering course is part of the second year curriculum. The senior students' reliance on code-and-fix strategies serves as an indication that they lack a thorough design phase in their development process.

FIGURE 5: PREFERRED SOFTWARE LIFE CYCLE



Without a process that accommodates designs, students would spend little time on design reviews and consequently would not be able to identify defects early in the development life cycle. The students therefore have to rely on code reviews and debugging as their primary technique for finding and fixing defects. When using code-and-fix strategies the "thinking" process of "how to solve a problem" would occur during the coding phase – not during the design phase – which explains why students spent most of their time in the coding phase. Since the students indicated "debugging" as their primary technique for fixing defects (see Figure 2) it is no surprise that they struggle to identify defects. They treat the consequence of a defect, which makes it a lot more difficult and takes more time to find the actual defect. This also explains why students see the "identification of defects" as a major contributor to poor results (see Figure 4). This effect will increase towards the third year when assignments are more comprehensive – therefore making it more difficult to identify defects. The student, however, will not realise this because he/she is using exactly the same process that worked for him/her from the first year. This explains why there is almost no difference in the time spent in phases from first to third year (see Figure 1).

CASE 2: CASE STUDY

Initial analysis of the Case 2 survey data revealed that the voluntariness and perceived behavioural control – internal constructs displayed low construct reliability (Cronbach's alpha < 0.64). Only the 10 remaining constructs were therefore retained for further analysis (see Table 2).[2]

TABLE 2: CONSTRUCTS RETAINED

Construct	Scale items	alpha
Behavioural intention (BI) Mean = 3.6809 SD = 0.45951	• I intend to use QATs in future programming tasks. • Given the opportunity, I would use QATs.	0.640
Usefulness (U) Mean = 3.4433 SD = 0.37795	• Using QATs improves my programming performance. • Using QATs increases my productivity. • Using QATs enhances the quality of my programs. • Using QATs makes it easier to do my programming tasks. • The advantages of using QATs outweigh the disadvantages. • QATs are useful in programming tasks.	0.681
Ease of use (EOU) Mean = 2.8156 SD = 0.45872	• Learning QATs was easy for me. • I think QATs are clear and understandable. • Using QATs does not require a lot of mental effort. • I find QATs easy to use. • QATs are not cumbersome to use. • Using QATs does not take too much of my time.	0.663
Subjective norm (SN) Mean = 3.0071 SD = 0.73717	• People who influence my behaviour think I should use QATs. • People who are important to me think I should use QATs. • My fellow students think I should use QATs.	0.760
Compatibility (C) Mean = 2.9504 SD = 0.56027	• QATs are compatible with the way I develop systems. • Using QATs is compatible with all aspects of my programming tasks. • Using QATs fits well with the way I work.	0.783
Image (IMG) Mean = 2.9929 SD = 0.67204	• Software developers who use QATs have more prestige than those who do not. • Software developers who use QATs have a high profile. • Using QATs is a status symbol amongst software developers.	0.745
Visibility (VIS) Mean = 2.4521 SD = 0.68888	• QATs are very visible at the Department.[3] • It is easy for me to observe others using QATs. • I have had plenty of opportunity to see QATs being used. • I can see when other students use QATs.	0.748
Personal behavioural control – external (PBC-E) Mean = 2.8553 SD = 0.57891	• Specialised instruction and education concerning QATs is available to me. • Formal guidance is available to me in using QATs. • A specific group is available for assistance with QATs difficulties. • For making the transition to QATs, I felt I had a solid network of support (e.g., knowledgeable fellow students, student assistants, lecturers, etc.). • The Department provides most of the necessary help and resources to enable students to use QATs.	0.724
Career consequences (CC) Mean = 3.2270 SD = 0.59123	• Knowledge of QATs puts me on the cutting edge in my field. • Knowledge of QATs increases my chance of getting a job. • Knowledge of QATs can increase my flexibility of changing jobs. • Knowledge of QATs can increase the opportunity for more meaningful work. • Knowledge of QATs can increase the opportunity for preferred jobs. • Knowledge of QATs can increase the opportunity to gain job security.	0.841
Result demonstrability (RD) Mean = 3.1383 SD = 0.6273	• I would have no difficulty telling others about the results of using QATs. • I believe I could communicate to others the consequences of using QATs. • The results of using QATs are apparent to me. • I would have no difficulty explaining why QATs may or may not be beneficial.	0.825

3 Although the true name of the academic department and institution concerned was used on the actual instrument it will not be disclosed here in order to protect the anonymity of the selected institution.

The next step was to identify the constructs that can be regarded as significant determinants of students' intentions (BI) to use QATs. Each construct was tested individually using least-squares regression analysis. Table 3 shows the results of each construct test – indicating the names of the constructs as well as the beta coefficients, significance levels and R^2 values.

TABLE 3: REGRESSION ANALYSIS OF CONSTRUCTS

Construct	β	Standard error of β	t	Sig.	R^2
Ease of use	0.412	0.136	3.023	0.004**	0.169
Compatibility	0.341	0.111	3.065	0.004**	0.173
Usefulness	0.467	0.167	2.788	0.008**	0.147
Result demonstrability	0.280	0.101	2.779	0.008**	0.146
Subjective norm	0.224	0.870	2.587	0.013*	0.129
Career consequences	0.274	0.108	2.526	0.015*	0.124
Personal behavioural control – external	0.216	0.114	1.897	0.064	0.074
Visibility	0.156	0.097	1.614	0.113	0.055
Image	0.139	0.100	1.396	0.170	0.041

Notes: * p<0.05, ** p < 0.01

Ease of use and compatibility showed the highest significance followed by usefulness and result demonstrability ($p < 0.01$). Subjective norm and career consequences were also significant ($p < 0.05$) while PBC-E, visibility and image were not significant. A comparison between these significant determinants and those identified in Riemenschneider et al.'s (2002) study reveal some interesting commonalities as well as several notable differences. When compared to the six significant determinants identified in the present study, Riemenschneider et al.'s study only identified compatibility, usefulness and subjective norm as significant determinants of methodology use intentions.

The results of this research study show that the perceived compatibility of software process innovations (such as QATs) with a developer's pre-existing software development process have a highly significant influence on intention to use. Chan and Thong (2009, p. 811) emphasise that the adoption of innovations often requires a radical change in the developers' existing work practices. If the innovation is not compatible with the developers' current practices they are unlikely to perceive it as beneficial. In a study comparing the PSP experiences of first-year and graduate students, Runeson (2001) concludes that it is easier to convince first-year students to use PSP as part of their development process since they have not yet formed established development habits.

There are numerous examples of prior studies that have found perceived usefulness as a significant factor in predicting professional developers' intention to use software process innovations such as software development methodologies (Chan & Thong, 2009; Riemenschneider et al., 2002;), programming languages (Agarwal & Prasad, 2000) and CASE tools (Iivari, 1996). Overall, these studies suggest that an innovation is only likely to be accepted if it is perceived as useful in increasing job performance (Chan & Thong, 2009). Similar to software developers in an industry environment, student developers are also influenced by a reward structure. They want to be productive and attain high marks for their assignments. If they do not see QATs as beneficial to their productivity they are unlikely to regard it as useful.

In support of prior studies, the Case 2 results also show that subjective norm significantly affects intention. Riemenschneider et al., (2002) warn that developers who believe in the usefulness and compatibility of a software process innovation might avoid using the innovation because of the negative views of peers and supervisors who oppose the use thereof. Chang and Thong (2009) conclude that the significance of subjective norm as a determinant can be attributed to the importance of teamwork in software development. The student software developers in the context of Case 2 are also required to complete a number of group projects. Even in cases where they are working on individual projects the students often form study groups to help one another. This creates a social learning environment where students could be subjected to peer influences. Students at the University of Utah who followed PSP practices during pair programming activities reported a higher level of enjoyment and higher confidence levels in their own work (Börsteler et al., 2002). These students also mentioned that they "encouraged each other to follow PSP practices" (p. 45).

The difference in the two studies regarding the effect of ease of use on adoption could possibly be attributed to the difference in contexts – working environment vs. education environment. While professional developers are already using the innovation, students are still in the process of learning how to use it. The professionals may have already moved beyond early concerns regarding the effort required to use the innovation (Chan & Thong 2009, p. 811). Chang and Thong (2009) also conclude that the diverse views on the resulting demonstrability of methodology use in Riemenschneider et al.'s study may be attributed to the long development cycles of real-world methodologies – preventing software developers "from observing the results in a short period of time" (p. 811). While the students in Case 2 have not necessarily used QATs in their own development projects they might believe that they have adequate theoretical

knowledge regarding the benefits of using QATs. In an attempt to improve students' utilisation of PSP, Williams (1997) found that even if students have theoretical knowledge of the process they might still struggle to apply it.

The significance of career consequences as a determinant of students' intention to use QATs could also be attributed to the educational context. Since students are preparing to enter the job market they are likely to regard their familiarity with industry-used techniques as something that will influence their chances of securing employment after the completion of their degree. In Börsteler et al.'s (2002) study students who have used PSP in their first-year course reported that their knowledge of software engineering principles helped them to obtain summer internships.

CASE 3: PROGRAMMING EXPERIMENT

The discussion in this section considers the data that was collected during Steps 2, 3 and 4 of the Case 3 programming experiment.

INSTRUCTOR OBSERVATIONS

The instructor made the following main observations while the students were completing the exercise:

- Students searched the Internet to find solutions for the exercise.
- No designs were created to solve the exercise problem.
- Some students forgot to start and stop the Process Dashboard© timer when switching phases.
- Some defects were not logged.
- Students struggled to distinguish between the "coding" and the "testing" phase.
- Students struggled to describe their logged defects.

The students did not log the re-work coding in the correct phase. Most of them logged that time under coding, which explains why re-work or testing time was lower than coding time (also see section on Process Dashboard© performance data.). More precise measurements would result in much higher testing times. Towhidnejad and Salimi (1996) also reported that only half of their students collected accurate and reliable data.

PROGRAM CODE

Not one of the students in the group produced a fully-functional program (according to the given specifications) during the allotted time frame. Two of the students (Student A and Student B) created programs that accomplished almost all of the given requirements. Both of their programs generated the specified number of player lotto draw records and wrote these records to the output file. They were, however, unable to calculate the draw date and draw number (for each record generated), which also had to be part of the output file. Students C, D and E had executable programs. Student C's program could only generate a fixed number of lotto draw records (10) without duplicates, while the output was written to the screen instead of the required text file. These draw records also did not include the draw date and draw number. Student D's program calculated incorrect draw numbers and wrote these numbers to the screen. Student E's program only contained a user input screen with no code to solve the lotto draw problem. The program created by Student F could not be executed. Inspection of the intended code logic revealed that his program was unable to generate any random numbers and did not contain any code to generate output.

PROCESS DASHBOARD© PERFORMANCE DATA

The six students on average spent 135 minutes each to create the program. This time frame included all phases of development: planning, design, coding and testing. The instructor decided to end the programming exercise after two and a half hours, as enough useful experimental data was accumulated. At that time the students also indicated that they would not be able to identify and fix all remaining defects even without a time limit.

On average the students spent their time as follows:

- 17% on planning;
- 1% on design;
- 0% on design reviews;
- 45% on coding;
- 1% on code reviews; and
- 36% on testing or debugging.

The actual time that these students captured while working shows a good correlation with the times reported in the pre-survey (see Figure 1). The actual testing or debugging time, however, would be much higher if these students had to continue to produce fully-functional programs. The students on average produced 45 lines of code, which resulted in a productivity of 20 lines of code per hour. Each student recorded an average of five defects, with 90% of these defects injected during coding. The limited time spent on designs also indicates that most defects would be injected during coding. Ninety-five percent of the defects were removed in the testing phase – an indicator that debugging was used as the primary technique for defect removal. Given that only 1% of the time was spent in reviews, this would yield few defects (2%) to be found during reviews. No design reviews were conducted because of the lack of designs and only 1% of the time spent on the design phase. This resulted in defects being discovered late in the development life cycle (testing), which makes it more difficult to identify them.

POST-ACTIVITY SURVEY

Students indicated that capturing time measurement data in the correct phases was easy, but identifying and describing defects was difficult. For process improvement some students indicated that they would spend more time on creating effective designs, and need to learn the skill to do effective reviews to pick up defects earlier in the life cycle. Participants in Prechelt and Unger's (2000) study made almost identical remarks. In McAlpin and Liu's (1995) study the programmers' software quality increased because they were motivated to spend more time on designs and reviews.

Most students were surprised by how much time they spent on testing and indicated that debugging might not be the most effective way to find and fix defects. In one of Humphrey's (1994) earlier studies about process feedback he remarks that programmers are typically surprised at how much data they can gather from small exercises and how quickly they can start using the measurement data to improve their personal software practices.

INTERVIEWS

An interview was conducted with each student in order to gain a deeper understanding of the development processes each one followed to create the program. The only artefacts that the students created (in addition to the captured Process Dashboard© measurement data) were the actual code (see section on Program code). The students did not create designs and therefore these interviews focused on what each student did during the problem-solving process.

The students all indicated that their first step in solving the problem was to do an Internet search for possible solutions. They all found code that they thought could possibly solve the problem. They copied the code and then tried to change it to solve the problem. As part of Feiner and Krajnc's (2009) experiment they asked their students what their first step would be in solving a given programming assignment. They report that most of their students indicated that they would search "the Internet" or "use Google" first. A survey conducted at the end of their experiment also revealed their students' general acceptance of "Copy & Paste" programming as part of their software development process (Feiner & Krajnc, 2009, p. 84). All the students in our experiment indicated that this is the method they usually follow when completing their programming assignments.

In retrospect, all the students indicated that they should rather have started by first solving the problem logically (using flowcharts or pseudo code) and then searched for code snippets to accomplish specific tasks. They also indicated that they do not find it easy to write pseudo code to solve problems and therefore prefer to search for code solutions where the logical thinking has already been done. Generally, they find it "hard to start" solving a problem.

CONCLUSION

In this paper various attributes contributing to the poor quality of student programs have been mentioned. The findings of Case 1 revealed that most students rely on a process of "code-and-fix", as predicted by Humphrey (1999). "Code-and-fix" remains the predominate process of choice from first- to third-year level, which indicates no process improvement through these years of study. Students also regard "testing" as the most effective strategy to remove defects. The case study conducted in Case 2 revealed that students' usage of QATs is driven by ease of practice, compatibility, convenience, result demonstrability, subjective norm and career consequences. These usage intentions differ from those identified in studies that involved professional programmers (Agarwal & Prasad, 2000; Chan & Thong, 2009; Iivari, 1996; Riemenschneider et al., 2002). More in-depth research is needed to identify additional factors that could possibly affect students' desire to use QATs. After a selected group of third-year students participated in a practical experiment (Case 3), they – through the use of process measurement data – realised (1) how much time they were actually spending on testing or rework, and (2) that testing is not the most effective method to find and solve defects. Process-measurement data could therefore be regarded as a potential contributor to the usefulness construct of students' willingness to adopt QATs.

The students' feedback indicated that they also lack design and problem-solving skills. This provides further verification for the findings of McCracken et al.'s study (2001). This lack of design and problem-solving skills could potentially be the main driver behind the students' preference towards a "code-and-fix" development process. However, data collected during Case 3 revealed that the students' development process could rather be described as "copy-paste-and-fix", since very little code was produced from scratch. An in-depth investigation is necessary to see if "copy-paste-and-fix" is the prevailing development process for most undergraduate computer programming students. If this is found to be the case, educators could focus on equipping students with proper "Copy and Paste" skills [as suggested by Feiner and Krajnc's (2009)]. While additional attempts to improve students' code reading and interpretation skills could advance their ability to review and debug their own code (Perkins et al., 1989), it could also enable them to effectively reuse code snippets copied from the Internet and other sources. It is, however, recommended that educators enforce effective design techniques from the first programs that students write in an effort to ensure that they will not fall back on an unstructured "code-and-fix" or "copy-paste-and-fix" life cycle. Case 3 has shown that the effect of process-measurement data should be regarded as a valuable contributor to any process improvement changes that educators want to enforce on students. The ultimate ideal is that students be able to adapt their processes according to their personal data.

ACKNOWLEDGMENTS

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THEMATIC SECTION:
INFORMATICS FOR DEVELOPMENT



THEMATIC SECTION: GUEST EDITORIAL: INFORMATICS FOR DEVELOPMENT

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Informatics is a diverse field of study, with a focus on the transformation of information and, specifically, on how information is processed and communicated. The domain of informatics for development revolves mainly around the role of ICTs for "sustainable socio-economic development". It also analyses and reflects on the contribution of ICTs to public services and in the broader public sector.

The role of development informatics will become increasingly more strategic in light of the United Nations' recently released set of Sustainable Development Goals (SDGs). These seventeen SDGs replace the UN's 2001 Millennium Development Goals (MDGs), which expire at the end of 2015. The SDGs are a reworked set of global targets, agreed upon by 193 UN member states. Each country will face specific challenges in pursuit of this sustainable development agenda and the SDGs will be used to frame each country's development policies over the next 15 years. Sustainable development goals for areas like health and education will require innovative, well-researched and bold policy interventions. Much of what may be achievable will need to be framed by a research agenda that supports these policy initiatives.

While there may be some dissenting voices around the SDGs, with some commentators arguing that the large number of goals will make it unwieldy and may diffuse effort, there is, however, no doubt concerning the vital role that ICTs will have to play if there is to be any meaningful attempt at achieving these goals. ICTs offer a set of enabling tools and services for development and are explicitly mentioned in the sustainable development agenda. ICTs are transformational technologies and enable the Schumpeterian view of "leapfrogging", thus allowing all countries to close many technology gaps. Closing technology and development gaps is vital if countries, especially developing countries, are to make any significant impact on their developmental targets.

Reflecting briefly on the articles included in this edition, it is evident that in line with the diverse research focus of the informatics for development research domain, the submissions received similarly spanned a wide range of topics, including the role of Twitter in predicting stock exchange movement, an analysis of ERP systems, Internet of Things and cyberbullying. A post-2015 research agenda will have an enormous impact on the success of any sustainable development agenda and the academic study of development informatics must pay close attention to this new developmental impetus. Good development research should be structured around a conceptual framework or model and it must ensure that it rigorously applies appropriate research methods.

CRITICAL INSIGHTS INTO THE DESIGN OF BIG DATA ANALYTICS RESEARCH: HOW TWITTER "MOODS" PREDICT STOCK EXCHANGE INDEX MOVEMENT

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ABSTRACT

The research explored whether one or more of the South African Twitter moods could be used to predict the movement of the Johannesburg Stock Exchange (JSE) All Share Index (ALSI). This is a proof of principle study in the field of big data analytic research in South Africa, which is at a relatively early stage of development. The research methods used secondary data from Twitter's application programming interfaces (APIs), and formulated a model to extract public mood data and search for a causal effect of the mood on the closing values of the JSE ALSI. Over three million tweets were gathered and analysed over a 55-day period, with data collected from the JSE for 39 weekdays, from which only one variable (mood states) was considered. Four of the South African Twitter mood states did not produce any correlation with the movement of the JSE ALSI. The mood Depression had a significant negative correlation with the same day's JSE ALSI values. The major finding was that there was a highly significant positive correlation between the Fatigue mood and the next day's closing value of the JSE ALSI, and a significant causality correlation from the Fatigue mood to the JSE ALSI values. The findings support the behavioural finance theory (Wang, Lin & Lin, 2012), which states that public mood can influence the stock market. Organisations and governments could use Twitter data to gauge public mood and to ascertain the influence of public mood on particular issues. However, very large data sets are required for analytical purposes, possibly five to ten years of data, without which predictability is likely to be low.

KEYWORDS

twitter moods, predict, stock exchange index movement, big data analytics, Africa and developing countries.

INTRODUCTION: A PROOF OF PRINCIPLE STUDY

Predicting stock market movements has motivated researchers and practitioners to formulate new models and methodologies (Atsalakis, Dimitrakakis, & Zopounidis, 2011). The daily fluctuations of the Dow Jones Industrial Average (DJIA) was predicted with an 86,7% accuracy using Twitter public moods by Bollen, Mao and Zeng (2011). Research into public moods has been of interest to academics from several disciplines, such as psychology (Stolarski, Matthews, Postek, Zimbardo, & Bitner, 2014), social science (Johnston & Newman, 2014), politics (Ellis & Faricy, 2011), and information sciences (Li, Wang, Li, Liu, Gong, & Chen, 2014). Practitioners from government (Hakhverdian, 2012) and industry (Bollen, Mao, & Zeng, 2011) appear to be interested in public moods, and their effects.

The aim of this proof of principle study was to understand the complexities involved in designing a study to explore whether analysis of one or more of the South African Twitter public moods could be used to predict the movement of the Johannesburg Stock Exchange (JSE) All Share Index (ALSI). The study engages with big data research approaches and methodologies, which are at a relatively early stage of development in South Africa (Kahn, Higgs, Davidson, & Jones, 2014). This preliminary study could be utilised as the foundation for designing studies for other African stock exchanges. Premier stock exchanges such as the London Stock Exchange (LSE) may be interested in the study, as it has relevance to their potential partnerships with African stock exchanges, including Egypt, Kenya, Morocco and Nigeria, as reported by Blas (2014). Forgha (2012, p. 176) stated that there are "twenty nine stock exchange markets in Africa, twenty one are members of the African Securities Exchanges Association (ASEA)". It is unclear if several have closed down as, according to the World Stock Exchanges (2014), there are 16 stock exchanges in Africa, four each in North and East Africa, three in West Africa, and five in Southern Africa. Irrespective of the number of stock exchanges in Africa, this study could be replicated for these countries and their stock exchanges.

The research was conducted in South Africa, using 3,104,364 tweets from within South Africa, and the daily closing prices of the Johannesburg Stock Exchange (JSE) All Share Index (ALSI), over a 55-day period. The tweets were tweeted by 282,211 unique users. Of the collected tweets, 2,305,063 tweeted by 259,671 unique users had "feeling" scores. The study analysed publicly available data downloaded from Twitter, using two of Twitter's application programming interfaces (APIs), and the closing values of the JSE ALSI. A model (XPOMS) was developed based on the Profile of Mood States (POMS) to extract the mood from Twitter data and quantitative analysis was conducted to extract the moods from these South African tweets. XPOMS generated a score for 2,3 million tweets which had "feeling" scores. The moods as defined by the XPOMS model were then mapped against the JSE ALSI closing values to see whether it was possible to use one or more of the moods to predict the movement of the ALSI.

The research focused on a microstructure of the market, rather than the market as whole. Market microstructure has been defined by O'Hara (2003) as the "study of the process and outcomes of exchanging assets under a specific set of rules". More commonly, this refers to the trading mechanisms used for real financial assets and the effect on price information and discovery, transactions costs, market structure and investor behaviour. The relationship between the transparency of such information and the process by which the price is determined was focused on. The value of publishing this work now is that it is one of the building blocks towards the future full-scale analysis of stock exchange index movements.

In 2014, South Africa was estimated to have a population of 54 million (StatsSA, 2014) and an annual gross domestic product of ZAR3,008 trillion (StatsSA, 2015). The World Bank ranks South Africa as an upper-middle income economy. In April 2011 it joined BRICS (Brazil, Russia, India, China, South Africa), a forum for economically significant emerging economies (Khan, 2011). South Africa has 11 official languages and is considered a country with a diverse range of cultures (Mwakikagile, 2010).

The Johannesburg Stock Exchange (JSE) Limited, established in 1887, is South Africa's stock market and the biggest in Africa (Eita, 2012). The market capitalisation grew from USD151 million in 1998 (Eita, 2012) to nearly USD1 billion in 2015 (ZAR12 368 billion on 20 July) with approximately 400 listed companies, making it the 19th largest in the world (JSE, 2015). Initiatives to improve the JSE's functioning were introduced in the late 1990s, including the Stock Exchanges Control Amendment Act 54 of 1995, an electronic clearing and settlement system, and a real-time stock exchange news service (Eita, 2012). Further legislative change was introduced in 2005 with the passage of the Securities Services Act No 36 of 2004, which aims to align with international regulatory practice.

The research focused on one particular index of the FTSE/JSE Africa Index Series, namely the All Share Index (ALSI). "The JSE All Share Index is calculated based on component share prices that are averaged according to specific rules which are impacted by stock splits and dividends" (Campbell, 2011, p. 4). Research on predictability has previously been conducted with respect to the JSE, in which it was found that past and present values of inflation can help predict the JSE returns (Eita, 2012). Evidence has been found for the predictive ability of simple technical trading rules on the JSE; however, the results lack statistical significance (Campbell, 2011). The yield curve has also been found to be a powerful tool for predicting down-swings on the JSE (Clay & Keeton, 2011).

LITERATURE REVIEW: MOODS AND PREDICTIVE CAPABILITY

The literature search commenced with the article "Twitter mood predicts stock market" by Bollen et al. (2011), which called for future studies to factor in location and language. This study attempted to replicate the Bollen et al. (2011) work in a developing world context, using a refined analytical tool. Articles from the reference section of the Bollen et al. (2011) article, as well as articles that referenced the Bollen et al. (2011) article were reviewed. Google Scholar was used to find articles on relevant topics including Twitter, mood states and stock exchange prediction, and the JSE. Twitter's website was also searched for useful information. The literature review investigated the current state of knowledge on using Twitter moods to predict stock market movements, on its limitations in making predictions, and on how the topic fits into the wider context, as suggested by Saunders, Lewis and Thornhill (2009).

TWITTER

Since Twitter's inception in 2006, it has seen tremendous growth, with 140 million active users posting 340 million tweets daily (Golbeck, Grimes, & Rogers, 2010; Rios & Lin, 2012). "Twitter is an Internet social-network and micro-blogging platform with both mass and interpersonal communication features for sharing 140-character messages, called tweets, with other people, called followers" (Chen, 2011, p. 755). Users tweet on everything, including the weather, news, sports results, and their feelings and moods. South Africa has over 1,1 million registered Twitter users (Vermeulen, 2012).

PROFILE OF MOOD STATES (POMS)

The Profile of Mood States (POMS) is a simple low-cost, user friendly instrument whose factor-analytical structure has been validated numerous times, which has been used in hundreds of research studies, and has been normed for various populations (Pepe & Bollen, 2008). The POMS questionnaire (McNair, Lorr & Droppelman, 1971) measures six dimensions of mood, namely Tension-anxiety, Depression-dejection, Anger-hostility, Vigour-activity, Fatigue-inertia and Confusion-bewilderment (Pepe & Bollen, 2008). POMS and derivations of POMS are simple instruments, which are not machine-learning algorithms.

Public moods can be tracked with the use of large-scale surveys, but the accuracy is limited by the degree to which the indicators correlate with public mood (Bollen et al., 2011). Great improvements have been made in the use of social media, such as Twitter, to track public mood (Bollen et al., 2011).

TWITTER MOOD CLASSIFICATION

Although many Fortune 500 companies are using social media platforms such as Twitter to interact with customers (Culnan, Mchugh, & Zubillaga, 2010), few are mining customers' tweets or moods. Bollen et al. (2011) classified Twitter moods using two tools, firstly OpinionFinder, which analysed tweets on a positive versus negative mood scale, and secondly Google-Profile of Mood states (GPOMS) derived from POMS. GPOMS classifies public mood according to six dimensions, namely Calm, Happy, Kind, Alert, Vital and Sure (Bollen et al., 2011). In this 2012 study, a new tool called Extended Profile of Mood States (XPOMS) was developed which included Afrikaans terms to classify the Twitter stream and search data. XPOMS had the same six moods as the original POMS, namely Depression, Tension, Anger, Vigour, Fatigue and Confusion.

STOCK EXCHANGE PREDICTION

A generation ago, academic financial economists accepted the efficient market hypothesis (EMH) as the leading theory for stock market prediction (Malkiel, 2003). "This hypothesis is associated with the view that stock market

price movements approximate those of a random walk. If new information develops randomly, then so will market prices, making the stock market unpredictable apart from its long-run uptrend" (Malkiel, 2005, p. 1). The implication is that stock market trends can only be predicted with 50% accuracy, according to EMH (Bollen et al., 2011). Lately, however, economists doubt the efficiency of EMH (Malkiel, 2005), and Bollen et al. (2011) identified two issues with EMH. The first problem is that several studies have concluded that stock prices can, to a certain degree, be predicted and do not follow a random walk (Bollen et al., 2011; Malkiel, 2003). The second problem is that, although news is unpredictable, early indicators can be extracted from social media to predict economic indicators (Bollen et al., 2011).

Other theories of stock market prediction have since emerged, such as behavioural finance (Bollen et al., 2011). "Behavioural finance combines behavioural and financial theory with the aim of analyzing the psychology, behavior and mood involved in financial decision-making, meaning the results of such research fall within the realms of both psychology and finance" (Wang, Lin & Lin, 2012, p. 696). Behavioural finance has proved that financial decisions are driven by mood and emotions (Bollen et al., 2011; Subrahmanyam, 2007). "Results indicate that the accuracy of Dow Jones Industrial Average (DJIA) predictions can be significantly improved by the inclusion of specific public mood dimensions but not others" (Bollen, Mao, & Zeng, 2011, p. 1). Subrahmanyam (2007) tied mood to stock market changes through behavioural finance, and Edmans, Garcia and Norli (2007) noticed that stock market changes can be influenced by sporting events, which affect the country as a whole. "This suggests that investor mood (ostensibly negative on cloudy days) affects the stock market" (Subrahmanyam, 2007, p. 17).

Event study analysis is concerned with measuring the impact of events on the value of companies and thus stock markets, using specific mathematical formulae (Dimpfl, 2011; Hart, 2006). Globally important news is processed quickly, and affects the volatility of stock markets (Dimpfl, 2011). Event study analysis could measure the validity of the XPOMS tool developed to see whether news events were picked up by Twitter moods, and to see whether events picked up and reflected by Twitter moods affected the JSE ALSI movement.

TWITTER MOOD PREDICTS THE STOCK MARKET

The correlation between public moods as gathered from Twitter with the DJIA was researched by Bollen et al. (2011). Between February 28 and December 19, 2008, almost 10 million tweets (9 853 498) were analysed to see if Twitter moods could predict the DJIA. Bollen et al. (2011) found that one of the moods (Calm) could indeed predict the DJIA with 86,7% accuracy. This review of the relevant literature informed the framing of the research question: Could one or more of the South African Twitter moods be used to predict the movement of the JSE ALSI?

RESEARCH METHODOLOGY

The research filled a gap revealed by Bollen et al. (2011) for further research on using Twitter moods to predict stock market movements in specific geographical areas. The purpose of this research was threefold, firstly as a further check on Bollen et al.'s (2011) methods and findings, secondly to attempt to predict stock market movements in South Africa, and thirdly to see if it would hold true for markets in a developing country such as South Africa.

From the research problem, the following hypothesis (and null hypothesis) was developed:

H1. One or more of the South African Twitter moods can be used to predict the movement of the JSE ALSI.
H10: One or more of the South African Twitter moods cannot be used to predict the movement of the JSE ALSI.
The movement of the ALSI of the JSE is the dependent variable, changing according to the independent variables, the South African Twitter moods.

The following six sub-hypotheses spring from the main hypothesis:

H2. Depression South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.
H3. Tension South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.
H4. Anger South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.
H5. Vigour South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.
H6. Fatigue South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.
H7. Confusion South African Twitter mood classified according to XPOMS can be used to predict the movement of the JSE ALSI.

The study will benefit many interest groups, including investors who are trying to make better decisions about stock market movements, as well as academics who study the predictability of the stock market or who study Twitter as a gauge for public mood. Stock market prediction has attracted research, with none being able to fully predict the market (Schumaker & Chen, 2009). Various studies have been conducted on predicting stock markets using a variety of methods (Atsalakis, et al., 2011; Bollen et al., 2011; Zhang & Wu, 2009).

The research was guided by a positivist philosophy, which entails "working with an observable social reality and that the end product of such research can be law-like generalizations similar to those produced by the physical and natural scientists" (Remenyi, Williams, Money, & Swartz, 1998, p. 32). The phenomena of Twitter moods can be observed and hypotheses developed to test whether the Twitter moods can be used to predict the movements of the JSE ALSI. A hallmark of the positivist approach is that the research is undertaken value-free, and data is collected unobtrusively (Saunders, et al., 2009). The data resources (Twitter moods and JSE ALSI closing values) were downloaded from the Internet, and the researchers were unable to influence either of these data sets. Complete freedom of the researchers' values is impossible and, in this case, Twitter search terms, geographical co-ordinates, XPOMS classification terms and time intervals of downloads could have been influenced by the researchers values (Saunders et al., 2009). Quantitative analysis (such as Spearman rank correlation and Granger causality) are closely associated with positivism (Saunders et al., 2009).

The approach to the research was deductive, in that the theory that Twitter moods can be used to predict stock market movement was tested. The following steps, as listed by Saunders et al. (2009), were followed in the research process. Firstly, theories from existing literature by Bollen et al. (2011) led to the deduction of seven hypotheses. These hypotheses were expressed proposing a relationship between two variables (South African Twitter moods and JSE ALSI closing values). The hypotheses were then tested, after which the outcome of the inquiry was examined and the theory revisited. Important characteristics of a deductive approach include the "search to explain causal relationships between two variables" (Saunders et al., 2009, p. 125). The independent variables were *Twitter moods* causing movements on the dependent variable, the JSE ALSI. "Studies that establish causal relationships between variables may be termed explanatory research: (Saunders et al., 2009, p. 140). The study tried to establish a causal relationship between two variables, hypothesising that South African Twitter moods can be used to predict the JSE ALSI movement.

Although data was collected over a two month period, the study was cross-sectional, because it focused on Twitter mood's ability to predict the JSE ALSI movement at a specific point in time, and not on how Twitter mood's ability to predict the JSE ALSI movement changed over time (Saunders et al., 2009). The population consisted of all tweets from within the borders of South Africa for a period of 55 days, and the daily closing price of the JSE ALSI over the same period, plus an additional five days to test for the effect of lag. Twitter exposes random tweets to the Streaming and Search APIs (GET statuses/sample, 2012), so the sample can be considered as a probability sample (Saunders et al., 2009). A total of 3,104,364 tweets were collected, tweeted by 282,211 unique users. In terms of language sampling, English and Afrikaans tweets were used, as these were the only two mentioned in a study done on Twitter language usage by Fischer (2011), and English and Afrikaans are the only two South African languages that form part of Twitter's translation project (Twitter Translation Center, n.d.).

The research tool developed and used to classify the Twitter stream and search data was called the XPOMS, based on POMS. The original POMS consist of six moods, namely Depression, Tension, Anger, Vigour, Fatigue and Confusion, represented by 65 words, which were retained in XPOMS (McNair et al., 1971). This research extended POMS, using Princeton University's WordNet application (WordNet, n.d.). A lexicon of additional terms that link back to the original POMS terms was created for XPOMS, and the terms were translated into Afrikaans using Google Translate. The extended and translated POMS terms were then used to identify one of the six POMS moods per tweet.

Figure 1 details the various applications and databases created to download and analyse South African tweets and the JSE ALSI closing values. tweets containing the following terms were downloaded: "I feel", "I am feeling", "I'm feeling", "I dont feel", "I don't feel", "I'm", "Im", "I am", "makes me". The English terms chosen were exactly the same as the ones used by Bollen et al. (2011), and these terms were also translated into Afrikaans. The end result (Table 1) showed the mood score value per day, calculated by adding up all the tweets falling into a specific mood, dividing that total by the amount of 'feeling' tweets for the day, and multiplying by a factor of 100. Table 1 also contains the JSE ALSI closing value plus lag of four days. APIs and program code are available from the authors on request.

FIGURE 1:THE APPLICATIONS AND DATABASES CREATED TO DOWNLOAD AND ANALYSE SOUTH AFRICAN TWEETS AND THE JSE ALSI CLOSING VALUES.

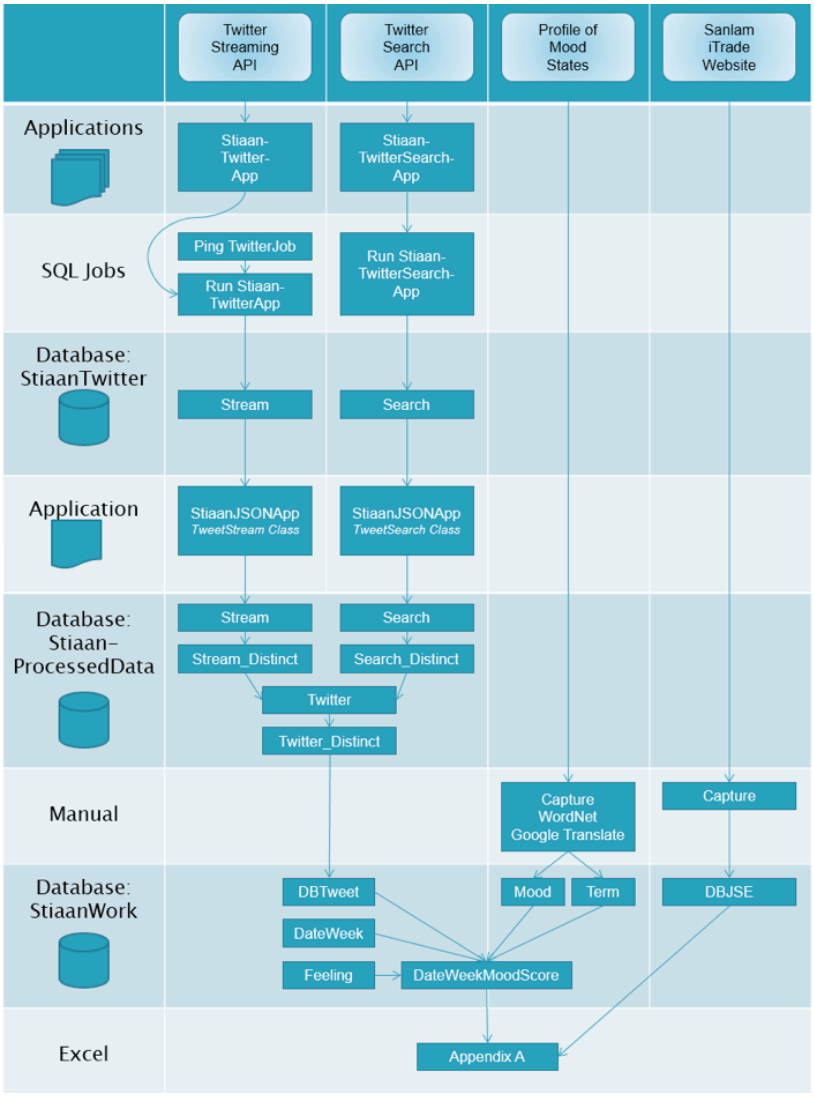


TABLE 1: SUMMARY OF MOOD SCORE VALUES AND ALSI CLOSING VALUES PLUS LAG OVER ONE, TWO, THREE AND FOUR DAYS.

End date	Total	Mood	Alsi	1-day lag	2-day lag	3-day lag	4-day lag
2012-06-11	0.397728673	Tension	33,617	33,855	34,038	33,826	33,960
2012-06-12	0.383339311	Tension	34,038	34,038	33,960	33,960	34,439
2012-06-13	0.372300819	Tension	33,826	33,826	34,439	34,439	34,714

RESEARCH FINDINGS AND ANALYSIS

The lag was tested for one to four days, as can be seen in Table 1. The research methodology was discussed and summarised in Figure 1; however the order of the analysis of the themes differed in that hypotheses H2 to H7 were discussed first, as the main hypothesis (H1) was dependent on these sub-hypotheses.

Of the data collected from 9 June to 2 August 2012, 2,305,063 tweets by 259,671 unique users had "feeling" scores and thus could be used for analysis. When examining the geographical data as entered by the users, places from across South Africa were represented. JSE ALSI data was collected for the period from 9 June to 8 August 2012 to include a four-weekday lag.

Applications used for analysis included: Microsoft Excel, Statistica 10, MATLAB, the Granger Causal Connectivity Analysis MATLAB Toolbox (Seth, 2010), R version 2.15 with MSBVAR (Brandt & Davis, 2012) and lmtest (Hothorn, Zeileis, Millo & Mitchell, 2012).

Data analytics according to XPOMS (H2 to H7)

The six weighted mood scores for the 39 days, along with the JSE ALSI closing values and values for one to four days lag, were used for the analysis as shown in the research process model (Figure 1). The six mood hypotheses were analysed against four rounds of tests, where each hypothesis could be accepted or rejected at the end of each round. The first round tested reliability and validity of the data, using basic statistical and event study analysis. The second round investigated Spearman rank correlations between the moods and JSE ALSI data with lags. The third round of tests involved testing causality of the relationships using the Granger causality test. Finally, in the fourth round, a neural network was set up to test actual prediction, as shown in Table 2.

TABLE 2: ANALYSIS OF SIX MOOD HYPOTHESES THROUGH FOUR TESTS

	Reliability & validity	Spearman	Granger	Neural network
Depression	?	?	?	
Tension	?	?	?	
Anger	?	?	?	
Vigour	?	?	?	
Fatigue	?	?	?	
Confusion	?	?	?	

The data from the DateWeekMoodScore and DBJSE was combined into one spreadsheet for all six moods, which formed the base on which all analysis was done. The basic statistics of the data were examined for reliability and validity by copying the data into Statistica. Table 3 details the results. The JSE data was not analysed as the JSE data was merely a listing of the day's closing ALSI values.

TABLE 3: DESCRIPTIVE STATISTICS OF THE SIX MOODS, AND THE JSE ALSI VALUES

	Valid N	Mean	Median	Minimum	Maximum	Lower-quartile	Upper-quartile	Varience	Std. dev.	Coef. var.	Skewness
Depression	39	6.38	6.36	5.77	6.87	6.18	6.57	0.1	0.2489	3.89952	-0.01194
Tension	39	0.36	0.35	0.25	0.5	0.32	0.39	0	0.0601	16.734	0.51985
Anger	39	2.26	2.23	1.97	3.08	2.17	2.34	0	0.2012	8.89979	2.39165
Vigour	39	3.73	3.66	3.37	4.48	3.55	3.92	0.1	0.2578	6.90752	0.88703
Fatigue	39	3.19	3.17	2.88	3.55	3.03	3.34	0	0.1915	5.99873	0.37921
Confusion	39	0.94	0.95	0.77	1.19	0.9	0.99	0	0.0822	8.7565	0.30856
JSE 0-day lag	39	34,085.9	33,999	33,253	35,071	33,793	34,289	184,411	429.43H1	1.25985	0.67083
JSE 1-day lag	39	34,127.6	34,035	33,253	35,244	33,815	34,292	212,138	460.584	1.3496	0.72676
JSE 2-day lag	39	34,169	34,038	33,253	35,469	33,815	34,439	255,779	505.746	1.48013	0.81152
JSE 3-day lag	39	34,206.1	34,041	33,253	35,487	33,815	34,534	299,628	547.383	1.60025	0.81273
JSE 4-day lag	39	34,248.9	34,070	33,253	35,495	33,815	34,597	337,664	581.089	1.69666	0.7565

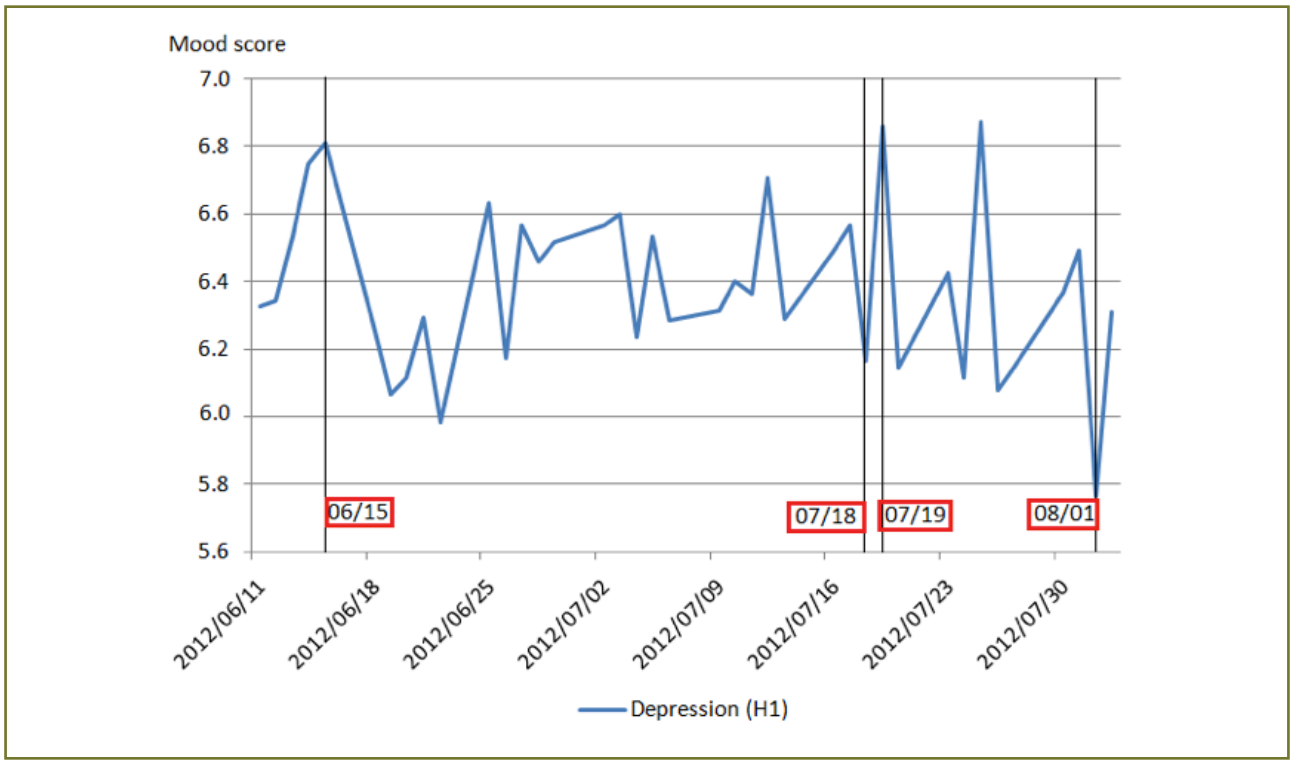
As can be seen in Table 3, the means and medians are close to each other, meaning that the average scores are close to the score in the middle (when arranged from biggest to smallest). In terms of skewness, only the Anger mood scores above 2; this means that it is probably skewed to a significant degree (Brown, 1997); all the other moods have low skewness scores. Reliability of the data examines whether the measuring tool consistently measures the data (Salkind, 2004), in this case whether the XPOMS tool and Twitter programs yield the same results consistently. Normally statistical reliability tests include test-retest reliability, parallel forms reliability and internal consistency reliability (Salkind, 2004).

A variation of test-retest was to split the 39 days' worth of data into two groups, then to compare means and standard deviations to see if the results of the two groups were more or less the same. When comparing the results for the first 19 days and the last 20 days, the major differences appear in the Anger row, where the maximum and standard deviations in the two tables differed. Compared to the basic statistics, the correlations between the means and standard deviation figures were significant ($p<0.5$), meaning that the XPOMS model and the Twitter programs measure results consistently.

Cronbach's Alpha (a coefficient of reliability) which measures internal consistency of a test or scale was not applicable, as it measures reliability of the same construct or concept, and the six moods did not fall into one construct to measure (Salkind, 2004; Tavakol & Dennick, 2011).

Validity is closely related to reliability and is "the property of an assessment tool that indicates that the tool does what it says it does" (Salkind, 2004, p. 289). This research used construct validity to "correlate the set of test scores with some theorized outcome that reflects the construct for which the test is being designed" (Salkind, 2004, p. 289), using event study analysis. Results of the moods were mapped to newsworthy events that might have influenced the scores of the moods. Results of all six moods were analysed and found to be impacted by news. As seen in Figure 2, a high Depression score occurred on June 15, 2012, due to news relating to the unavailability of school textbooks in many South African schools. Depression dipped on Nelson Mandela's birthday on July 18, 2012. The Depression mood in South Africa was very low when Chad le Clos beat Michael Phelps to Olympic gold on August 1, 2012.

FIGURE 2: NEWS EVENTS MAPPED ON DEPRESSION MOOD



The next step was to determine if any evidence of linear relationships existed between any of the moods and the JSE ALSI, including the four-day lag. This was done by running a Spearman rank correlation test on the data. When both variables are intervals, as was the case in the research, then the Spearman rank correlation coefficient is chosen to work out the correlation coefficient (Keller, 2012). Statistica was used where $p<0,01$ (Table 4).

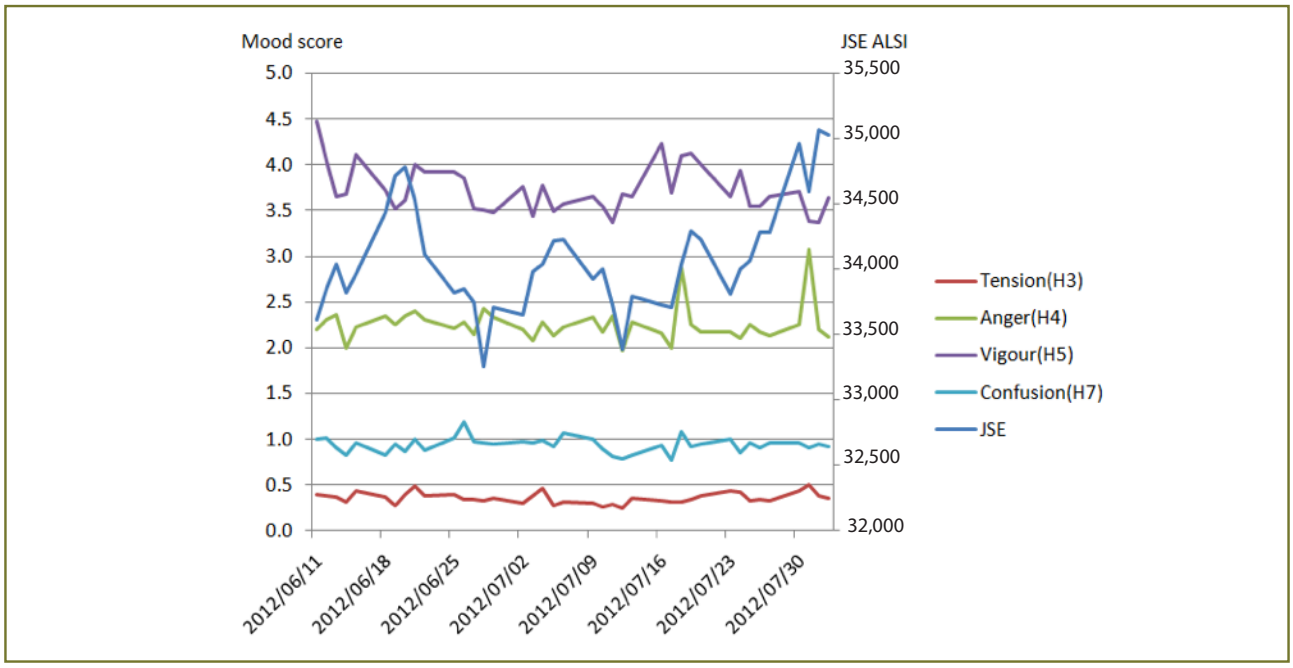
TABLE 4: DATASET SPEARMAN RANK CORRELATION (P < 0,01 IN RED)

	Depression	Tension	Anger	Vigour	Fatigue	Confu-sion	JSE 0-day lag	JSE 1-day lag	JSE 2-day lag	JSE 3-day lag	JSE 4-day lag
Depression	1.0000										
Tension	-0.1415	1.0000									
Anger	-0.2433	0.2490	1.0000								
Vigour	0.0059	0.2759	-0.0342	1.0000							
Fatigue	0.2466	-0.0506	0.1237	-0.1002	1.0000						
Confusion	-0.0164	0.1943	0.2140	0.2411	- 0.0753	1.0000					
JSE 0-day lag	-0.4641	0.2609	0.1806	-0.1293	0.2070	0.0325	1.0000				
JSE 1-day lag	-0.2544	0.2536	0.0480	-0.0389	0.4177	0.0355	0.7638	1.0000			
JSE 2-day lag	-0.1971	0.2684	-0.1645	-0.0671	0.3238	0.1420	0.5361	0.7917	1.0000		
JSE 3-day lag	0.0214	0.2382	-0.1918	-0.1282	0.3800	0.2659	0.4024	0.5897	0.8071	1.0000	
JSE 4-day lag	0.0252	0.2906	-0.1382	-0.0185	0.2957	0.1779	0.2562	0.4380	0.6213	0.8330	1.0000

When analysing the findings of the Spearman rank correlation coefficient, the significant values to note were marked in red. Table 4 has a high level of confidence (99%) and results were highly significant (Keller, 2012).

The hypotheses involved the Twitter mood as the independent variable and the JSE ALSI and lag values as the dependent variables, so correlations between these variables were examined first. It was interesting to note that no significant correlation exists between Tension, Anger, Vigour, Confusion and any JSE ALSI and lag values. As can be seen in Table 4, there were positive correlations between, for example, Anger and JSE four-day lag variables, but these correlations are not significant, because p>0,05. In Figure 3, the JSE ALSI values were mapped against the four moods, showing no noticeable correlation between the values.

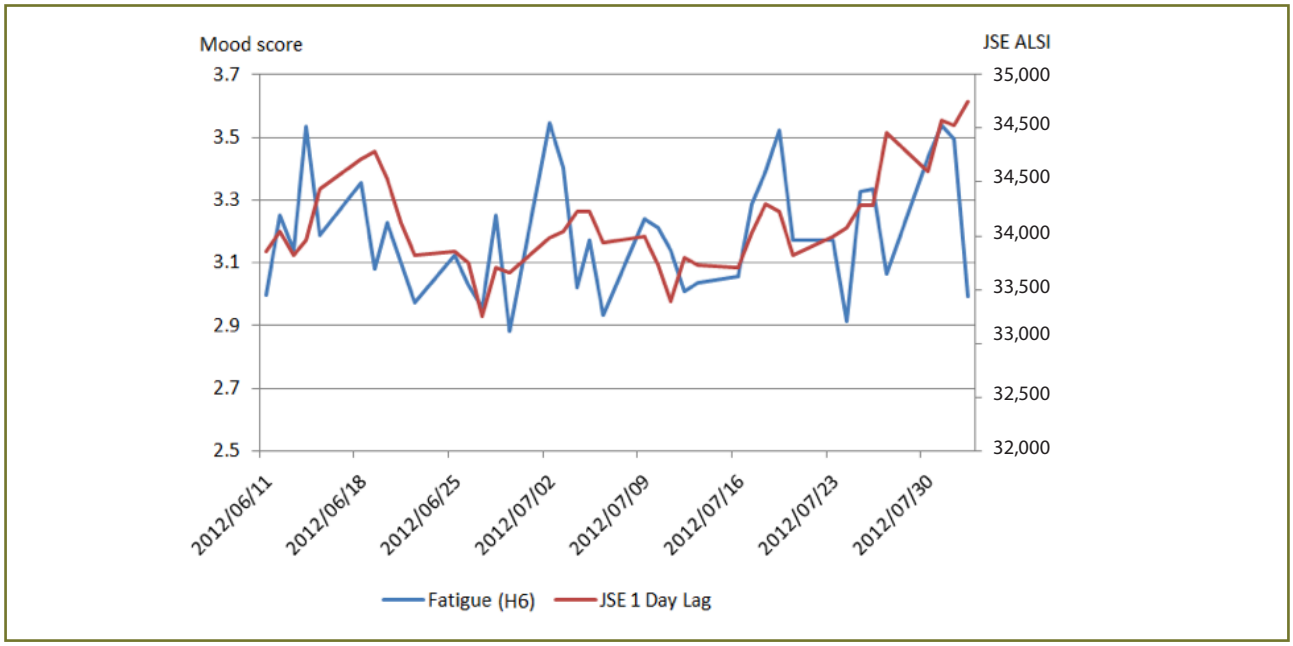
FIGURE 3 : COMPARISON OF FOUR MOOD SCORES WITH THE JSE ALSI



The interpretation of Figure 3 was that there were no relationships between Tension, Anger, Vigour, Confusion and any JSE ALSI and lag values. The independent variables had no bearing on the dependent variable; in other words, observing the Tension, Anger, Vigour, Confusion Twitter mood cannot be useful in predicting the JSE ALSI movement. This led to the acceptance of the null hypotheses for the four variables (H30, H40, H50 and H70).

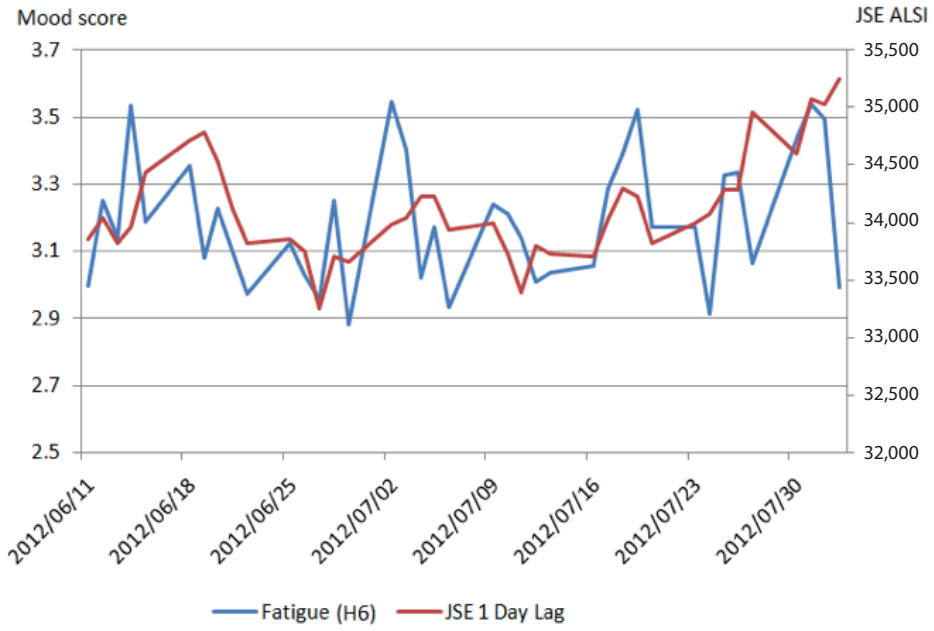
The first significant correlation between Twitter mood and the JSE ALSI was between Depression and the JSE same day ALSI values. The correlation coefficient was at -0,4641, where $p < 0,01$, thus highly significant. A negative correlation coefficient means that there is an inverse relationship between the two variables (Keller, 2012). When the Depression mood score went down, on the same day the JSE ALSI went up, and vice versa – when the Depression mood went up, on the same day the JSE ALSI went down. This relationship could be observed in Figure 4 between the Depression mood score indicated in blue and the JSE ALSI values in red. From 31 July to 1 August 2012 the Depression mood score fell from 6,49 to 5,77; while the JSE ALSI climbed from 34,597 to 35,071.

FIGURE 4: RELATIONSHIP BETWEEN THE DEPRESSION MOOD AND THE JSE ALSI



More significant correlations existed between Fatigue mood score and JSE ALSI values of one, two and three days' lag. Table 4 showed that positive correlations existed between Fatigue mood and JSE one-day lag (coefficient 0,4177), JSE two-day lag (coefficient 0,3238) and JSE three-day lag (coefficient 0,3800). The coefficients were significant ($p<0,05$) whereas the JSE one-day lag coefficient (0,4177) was highly significant with $p<0,01$. The research only focused on the highly significant correlations. The correlation coefficient was a positive one, thus the interpretation of the numbers was that when Fatigue mood score goes up, one day later the JSE ALSI goes up, and when Fatigue mood score goes down, one day later the JSE ALSI goes down. This effect can be seen in Figure 5. For example, from July 16 to July 17 2012 the Fatigue mood score climbed from 3,06 to 3,29 and the JSE ALSI with a one-day lag climbed from 33,707 to 34,035.

FIGURE 5: RELATIONSHIP BETWEEN THE FATIGUE MOOD AND A ONE-DAY LAG OF THE JSE ALSI



The Spearman rank correlation coefficients indicated that there were two moods that had highly significant correlations to the JSE ALSI values with lag. The question whether the correlations were enough to prove the hypothesis that the moods could predict the JSE ALSI movement was still unanswered. Thus, neither hypotheses nor null hypotheses for Depression or Fatigue could be accepted or rejected at this stage. Bollen et al. (2011, p. 4) used more than only Spearman rank correlation coefficients to prove prediction; they used the Granger causality test in order to test "whether one time series has predictive information about the other or not".

The focus of the research was to find out whether the JSE ALSI can indeed be predicted by South African moods on Twitter. Four null hypotheses were accepted, but significant correlations were found for two hypotheses (H2 and H6), which required further analysis. A significant correlation was found between Depression mood (H2) and the same day JSE ALSI and Fatigue mood (H6) and the next day's JSE ALSI. Thus the next round of analysis was to test the Granger causality correlation of these two hypotheses, as was done by Bollen et al. (2011). "According to G-causality, a variable X1 'Granger causes' a variable X2 if information in the past of X1 helps predict the future of X2 with better accuracy than is possible when considering only information in the past of X2 itself" (Seth, 2010, p. 262). For the analysis, three different algorithm packages in two different applications were used. The first software package, MATLAB, implemented the Granger Causal Connectivity Analysis MATLAB Toolbox, developed by Seth (2010).

Depression mood scores and JSE data for the same day were entered into MATLAB in a matrix. The Granger causality correlation, probability and thus significance were then worked out for a one-day lag, using MATLAB. Table 5 can be read as follows: according to the Granger causality test, the variable at the top (either 1a or 2b) causes the variable on the left (either 1A or 2B), with the significance as in the table. The Granger causality test significance with which Depression (1a) caused JSE values (2B) was 0,4634, which was insignificant, because p>0,05. What was interesting to note however, was that the Granger causality correlation from 2b to 1A was indeed significant, meaning that, with a one-day lag, JSE values caused a highly significant Depression mood on Twitter, according to the Granger causality test.

TABLE 5: MATLAB DEPRESSION JSE GRANGER CAUSALITY P-VALUE

	Variable 1a (depression)	Variable 2b (JSE)
Variable 1A (depression)	NaN	0.0013
Variable 2B (JSE)	0.4634	NaN

The findings were also inspected using R version 2.15, importing two packages, namely MSBVAR (Brandt & Davis, 2012) and lmtest (Hothorn et al., 2012). The Depression mood score and JSE data were imported into R, using a comma separated value (CSV) list. After running both Granger causality tests, similar results were observed to the MATLAB tests. Although the figures were slightly different from the MATLAB tests, the interpretations were exactly the same.

For both R tests, the probabilities that Depression mood caused JSE ALSI data using the Granger causality test were insignificant, as p = 0,456139621 > 0,05. Yet again, using the Granger causality test, the results showed that there was a highly significant (p = 0,001547018) correlation, which indicated that JSE ALSI values caused Depression

mood on Twitter. The findings resulted in the null hypothesis for Depression being accepted (H20). Depression mood cannot be used to predict the JSE ALSI movement, but JSE ALSI values can cause Depression mood.

The last XPOMS hypothesis that needed to be tested was the Fatigue mood score. The matrix was entered into MATLAB, similar to the Depression matrix and the Granger causality tests were run. Table 6 shows that there was a significant Granger causality correlation coefficient between Variable 1a (Fatigue) and Variable 2B (JSE). The coefficient meant that Fatigue mood caused JSE values, using a one-day lag, according to the Granger causality test.

TABLE 6: MATLAB FATIGUE JSE GRANGER CAUSALITY P-VALUE

	Variable 1a (fatigue)	Variable 2b (JSE)
Variable 1A (fatigue)	NaN	0.6313
Variable 2B (JSE)	0.0221	NaN

The same values were again tested in R using both the MSBVAR (Brandt & Davis, 2012) and lmtest (Hothorn et al., 2012) packages. The matrix was loaded into R using a CSV containing the Fatigue mood scores and the JSE ALSI closing values. As was observed when using the Granger causality test for the Depression mood, the scores from the R software looked slightly different from the MATLAB results, but the findings implied the same results.

Using the Granger causality test, the results indicated that there was a significant ($p = 0{,}0253 < 0{,}05$) correlation between Fatigue mood and JSE ALSI values with one day's lag. The result meant that Fatigue can indeed be used to predict the following day's JSE ALSI movement. The null hypothesis (H60) for Fatigue was thus rejected and the hypothesis (H6) accepted.

The last step of the research entailed implementing a neural network for prediction and seeing whether the addition of Fatigue mood scores made predictions more accurate. A table was populated in Microsoft SQL Server 2008 R2 with the following information: (i) the Fatigue mood score for the day, (ii) the JSE ALSI value for the day, along with (iii) the previous six days' closing values, and (iv) the effect that these would have on the next day's JSE movement. For the sake of programming, the up movement effect was marked as a 1 (or true) and the down as a 0 (or false). The table was then used to train a neural network. A Microsoft SQL Server Analysis Services project was created in Visual Studio 2008, from which a Microsoft Neural Network mining structure was created. The model used the Fatigue mood score and JSE ALSI values as input columns and was trained to predict the effect column. The neural network needed to use input data to make predictions. The input data was generated using a case table, which had the same columns as the training table, except for the effect, which the mining model would predict.

The same two-table structure was created for data that did not contain the Fatigue score, to see whether the addition of the Fatigue score made a better prediction possible. Another mining model was created using the same software. The result was that the historical JSE ALSI data only (no added Fatigue mood score) could predict 23 out of the 39 movements correctly. The addition of Fatigue mood score improved the prediction to 24 correctly predicted movements out of the 39. As the results indicated, the prediction was slightly more accurate with the addition of Fatigue mood scores, albeit very slightly. The availability of more days' worth of data would improve training of the neural network, and thus the accuracy of the prediction. When the details of the neural network were inspected, Fatigue mood score did not play a major role in the algorithm; in fact a Fatigue mood score of 3,320 to 3,547 was only the fourteenth most important determinant of movement.

The researcher was aware that using the same data (except for the Effect column) for training and cases was not ideal in implementing the predictive power of the Fatigue mood score. However, only 39 days were available for training and testing, and the alternative option (which was to break this data up into training and testing groups) would render inadequate results. The use of the neural network was simply a quick test to implement Fatigue mood score and see whether the use of this data would indeed improve predictions, which it did. Future research could include testing more days of Fatigue mood scores and JSE ALSI values, which would yield more options for prediction of JSE ALSI movement.

ANALYSIS OF TWITTER MOOD (H1)

The main theme of the research was to find out whether one or more of the South African Twitter moods could be used to predict the movement of the JSE ALSI. The main theme was broken into six sub-themes, each investigating a different mood. All the null hypotheses were accepted, except for Fatigue (H6), where the hypothesis was accepted. This meant that the Twitter mood, Fatigue, could be used to predict the movement of the JSE ALSI. The results were then tested using a neural network and, although only a small improvement in accuracy of prediction was detected, the addition of the Twitter mood Fatigue did make a positive contribution towards the results. The acceptance of the Fatigue hypothesis (H6) led the researcher to also accept the main theme hypothesis, H1.

OTHER ANALYSIS

Other important analysis conducted on the data included ignoring weekend tweets between Fridays 17:00 and Sundays 17:00. The reason for this was to have the same number of valid tweets per day so that the effect of this on lag could be tested. The same significant and highly significant results were shown by the Spearman rank

correlations; however, the magnitude of the coefficient was smaller in each case. The test did not have an improved effect on lag correlations, prompting the researcher to include weekend tweets.

SUMMARY OF FINDINGS

The data passed reliability and validity tests. Four null hypotheses were accepted after applying the Spearman correlation coefficient to the data, while H20 and H6 was accepted after the Granger test as summarised in Table 7.

TABLE 7: ACCEPTANCE OF SIX MOOD HYPOTHESES THROUGH STATISTICAL TESTS

	Reliability & validity	Spearman	Granger	Neural network
Depression			$H2_0$	
Tension		$H3_0$		
Anger		$H4_0$		
Vigour		$H5_0$		
Fatigue			H6	
Confusion		$H7_0$		

The acceptance of the Fatigue hypothesis (H6) led to the acceptance of the main theme hypothesis (H1), meaning that one of the South African Twitter moods, Fatigue, can be used to predict the JSE ALSI movement.

DISCUSSION: INTERPRETING SIGNIFICANT CORRELATION

One of the major findings of the research was that there was a highly significant negative correlation between Depression mood and the same day's JSE ALSI. When the Granger causality tests were run, it was discovered that there was, in fact, a significant causality relationship between the two variables, but exactly in the opposite direction, as hypothesised. The JSE ALSI influences the Depression mood on Twitter; when the JSE ALSI goes down, Depression mood on Twitter goes up. When generalising from data to an observation, "an increase in the sample size can increase the generalizability of the sample points to a sample estimate, but does not increase the generalizability of the sample estimate to the corresponding population characteristic" (Lee & Baskerville, 2003, p. 234). Thus, although the sample size was extensive, one could not generalise that all African stock market indices would influence the Depression moods in those areas.

The results of the research were similar to the study done by Bollen et al. (2011). The mood which could best predict the stock exchange, according to Bollen et al. (2011), was Calm (which transposes to Tension from POMS), whereas the research found that in South Africa, Fatigue was a better predictor. The biggest finding of the research was the positive correlation between Fatigue mood and JSE ALSI values with a one-day lag. No literature has been found that would explain this phenomenon, but the researcher argued as follows: The Fatigue mood score indicates that many people are feeling exhausted, tired, weary or lethargic. A person generally does not feel constantly fatigued and after appropriate remedy such as sleep and/or exercise (Berger & Motl, 2000), the day after the high Fatigue score, a positive effect is noticed on the JSE ALSI value.

Hart and Webber (2005) investigated the effect of information technology (IT) infrastructure investment on the value of the firms in South Africa, where no significant market reactions were identified. Bhattacharya, Daouk, Jorgenson and Kehr (2000) conducted a similar study in Mexico. One of the possible reasons for the lack of market reactions could be that "investors do not regard news announcements as value-relevant" (Hart & Webber, 2005, p. 50). The results of this study suggest that investors do regard news as value-relevant, when looking at the reaction of Le Clos's Olympic gold medal on both the Depression mood on Twitter and on the ALSI on the JSE.

Lastly, it is important to note that stock market prediction is a research field that has to be seen in context (Malkiel, 2003, p. 72):

> Given enough time and massaging of data series it is possible to tease almost any pattern out of every data set. Moreover, the published literature is likely to be biased in favour of reporting such results. Significant effects are likely to be published in professional journals while negative results, or boring confirmations of previous findings, are relegated to the file drawer or discarded.

As advised in the comment on the limitations of the study, more than 39 days' worth of data needs to be analysed in order to consistently and accurately predict JSE ALSI movements.

CONCLUSION: CAUSAL RELATIONSHIP BETWEEN MOOD AND INDEX

MOVEMENT OBSERVED

The research question was "Could one or more of the South African Twitter moods be used to predict the movement of the JSE ALSI?" A model (XPOMS) built on an existing psychological model (POMS) was developed to extract moods from Twitter. Seven hypotheses were developed to test each mood and the main theme of the research. Four of the six moods did not have any correlations between Twitter mood and JSE ALSI values, thus the null hypotheses for these four were accepted after doing a Spearman rank correlation test on the data.

A significant negative correlation between the Depression mood and the same day JSE ALSI values were found, but after a Granger causality test, the null hypothesis was accepted, because it seemed that the JSE ALSI caused the Depression mood, and not vice versa. The main finding of the research was that there existed a highly significant positive Spearman rank correlation between Fatigue mood and JSE ALSI with one day's lag. The Granger causality test revealed that there was a significant causal relationship between Fatigue mood and JSE ALSI, meaning that Fatigue mood causes JSE ALSI movements. The neural network used for prediction showed that the prediction results were slightly better with the addition of Fatigue Twitter mood.

Researchers in developing countries, particularly those researching African stock exchanges could find this research useful, as "spillovers to individual African countries evolve" (Sugimoto, Matsuki & Yoshida, 2013, p. 1). Researchers could investigate if the findings spill over to other African countries and stock exchanges.

Methodologically, the research could be improved by the collection of five to ten years' data to use for analysis. Reflecting on the research from a substantive point of view, the results were very similar to the findings of Bollen et al. (2011). The results did indeed strengthen the claim that Twitter mood can be used to predict stock exchange movements. The results also confirm behavioural finance theory, which states that public mood can influence stock markets (Subrahmanyam, 2007). The research adds to the scientific body of knowledge by confirming previous research, the development of the XPOMS model and the development of software, which can be used by future researchers.

A recommendation for future research would be to obtain more than 39 days' worth of Twitter data to match against the JSE ALSI, as well as other African stock exchanges. Other methodologies for working out the day's mood score could be applied to the data. For example, the use of a few days before and after the measured day's mean and standard deviation of the mood scores could be used in addition to the day's own mood score. Other correlations that might yield interesting results would be to investigate the correlations between moods, giving lag between days; this could answer questions such as does Anger Twitter mood cause Depression Twitter mood, and what influence does this have on stock market predictions? Event study could also be applied with more detail, using mathematical formulae (Hart, 2006). Given Twitter's immediate nature, intraday correlations between Twitter mood and stock exchange data could also yield interesting results.

To test the researcher's XPOMS model on Bollen et al.'s (2011) data, and Bollen et al.'s (2011) GPOMS model on the researcher's data, could have added another dimension of reliability and validity to the research.

The complexity of doing big data research and the scarcity of data centres which can collect, store, analyse, and manage the data resources are an issue which needs investigation (Kahn, Higgs, Davidson, & Jones, 2014).

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EXPERIENCES OF MISFIT AS CUES FOR SENSEMAKING OF ERPs

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ABSTRACT
The adoption of computer-based enterprise resource planning systems (ERPs) has become an important feature of large organisations in both the public and private sectors. Successfully embedding ERP systems in organisational structures does, however, pose a significant array of technical and social (human) challenges. Chief among these is ensuring that ERP users successfully adapt to new/changed work processes and tasks post-adoption. In this study Karl Weick's theory of Sensemaking is adopted to investigate the process by which users develop the meaningful understandings of ERPs. It is proposed that experiences of misfit, that result from user ignorance or organisation-artefact misalignment, act as triggers for sensemaking. Based on an integrated interpretive framework a case study of a South African Metropolitan Municipality is used to analyse 34 experiences of misfit and their consequences. Findings suggest that experiences of misfit trigger various types of response strategies during which users' understanding of and beliefs about ERP technology are updated.

KEYWORDS
enterprise resource planning systems, ERPs, metropolitan municipality, local government, technology adaptation, information systems adoption, sensemaking, misfit

INTRODUCTION: COGNITION AND TECHNOLOGY ADAPTATION

An important area of concern in the field of IS (information systems) has been the adoption of IT (information technology) artefacts by individuals and user communities (Benbasat & Barki, 2007; Mathieson, 1991; Parasuraman, 2000; Saeed & Abdinnour, 2013; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Research in this domain includes efforts to identify the factors that determine adoption behaviour, but also the process, often referred to as adaptation, by which adoption occurs among members of a user community. The importance of this area of research is rooted in the broadly accepted premise that the potential benefits of IT investments, while influenced by system quality, depend directly upon the nature, level and appropriateness (DeLone & McLean, 1992, 2003; Petter, DeLone, & McLean, 2013) of system usage. It follows that, while an IT artefact may be a technical success, its value for an adopting organisation can only be realised when it is successfully embedded in and integrated with organisational work systems (Alter, 2008).

Whereas behaviourist approaches have been utilised in the bulk of studies on adoption, there is a small but significant collection of scholars who have investigated the cognitive dimensions of adoption/adaptation (Askenäs & Westelius, 2003; Bansler & Havn, 2006; Beaudry & Pinsonneault, 2005; Berente, Hansen, Pike, & Bateman, 2011; Griffith, 1999; Henfridsson, 2000; Jackson, Poole, & Kuhn, 2002; Mishra & Agarwal, 2010; Orlikowski & Gash, 1993; Saeed & Abdinnour, 2013). Studies of this nature present a number of challenges. These include the collection of rich data through time-consuming techniques such as interviews or observation; as well as qualitative analysis informed by theories, models and methodologies generally imported from one or more reference disciplines (e.g., sociology or cognitive psychology). From these studies have emerged a body of knowledge, that addresses both the process by which IT artefacts become individually and socially constructed and the content or substance of these constructions. This study aims to extend this line of research by applying Karl Weick's theory of sensemaking to investigate the role of experiences of misfit as cues for sensemaking of a computer-based ERP (enterprise resource planning) information system by a South African metropolitan municipality. Experiences of misfit are broadly defined as incidents of individuals feeling that the software is "impeding the proper execution of organisational operations" (Strong & Volkoff, 2010, p. 733). While IS research generally frames experiences of misfit negatively (e.g., as evidence of failure to achieve organisation-artefact alignment) (Goodhue & Thompson, 1995; Kanellis, Lycett, & Paul, 1999; Kanellis & Paul, 2005; Soh & Sia, 2004; Strong & Volkoff, 2010), this study proposes that they act as triggers for users to make sense of the nature and role of a new technology in an organisation.

To investigate this proposition data collected during a case study of an ERP adoption project at a South African metropolitan municipality are analysed. Government and research reports provide strong evidence that South African municipalities face an array of managerial challenges with financial and supply chain management highlighted as areas of particular concern (Department of Cooperative Governance and Traditional Affairs Republic of South Africa, 2009; Department of Government Communications and Information System, 2012; Memela, Mautjane, & Nzo, 2008). In a 2009 report, COGTA (Department of Cooperative Governance and Traditional Affairs, Republic of South Africa) acknowledged that "a culture of patronage and nepotism is now so widespread in many municipalities that the formal municipal accountability system is ineffective and inaccessible" (Department of Cooperative Governance and Traditional Affairs Republic of South Africa, 2009). These findings are corroborated by a 2008 study which found that municipalities generally have very limited or no audit reporting capabilities, poor managerial leadership, a lack of performance reporting systems and a lack of acceptable organisational structures (Memela et al., 2008). Computer-based ERP systems have the potential to address these challenges by imposing legislation, regulatory frameworks and best practices upon organisational work systems (Askenäs & Westelius, 2003; Jacobs & Weston, 2007; Strong & Volkoff, 2010). While most small/rural municipalities lack the resources required to undertake extensive ERP adoption projects, metropolitan municipalities governing ever-growing urban areas are better positioned to harness the potential of ERP software packages.

WEICKEAN SENSEMAKING THEORY AND ITS APPLICABILITY TO INFORMATION SYSTEMS ADOPTION

The sensemaking concept has been used in a variety of ways. Snowden (2005), in the context of knowledge management (KM), defines it as "the way that humans choose between multiple possible explanations of sensory and other input as they seek to conform the phenomenological with the real in order to act in such a way as to determine or respond to the world around them" (Snowden, 2005, p. 46). Also notable is the work of Dervin (Dervin, Foreman-Wernet, & Lauterbach, 2003; Dervin, 2003) who developed the sense-making methodology – a widely applied communication-based research methodology which has been used in IS contexts (Foreman-Wernet, 2003; Naumer, Fisher, & Dervin, 2008). Further applications of sensemaking theory have been done in the field of human-computer interaction as a means to investigate the role of machines, and mental models of machines, in the processes by which humans become informed (Klein, Moon, & Hoffman, 2006a, 2006b). The most extensive and complete account of sensemaking as an organisational activity, however, is contained in the writings of Karl Weick (Daft & Weick, 1984; Weick, 1991, 1993, 1995, 1998, 2005; Weick & Quinn, 1999; Weick & Roberts, 1993; Weick, Sutcliffe, & Obstfeld, 2005).

Weick states that human actors perceive reality as a constant stream of experiences through ongoing processes of "automatic information processing" (Weick, 1995, p. 14). During these processes "present moments of experience" (referred to as cues) are extracted from the environment through the senses and placed in "perceptual frameworks" (or frames) to form a plausible understanding of reality. Meaning, accordingly, is created when a person can construct a relation between a cue and a frame. Over time and through exposure to a greater variety of experiences humans develop a repertoire of frames that enables them to create meaning out of a greater variety of cues.

His theory dictates that when actors are confronted with novel events these processes of automatic information processing are interrupted. Such interruptions may be insignificant and bridged with little cognitive effort, but when the disparity between an actor's expectations and perceived reality reaches a "threshold of dissatisfaction" – experienced as a "shock" – the actor is prompted to "pay attention and initiate novel action" to form a plausible understanding of events. Stated differently, shocks denote situations where an actor's inability to relate cues to frames leads to confusion and agitation which, Weick argues, form the wellspring of occasions for sensemaking.

Occasions for sensemaking may trigger a variety of responses aimed at re-establishing the sensemaker's plausible understanding of reality. Weick describes two drivers (or starting points) of these responses. When sensemaking is driven by beliefs it takes the form of arguing or expecting. Arguing occurs when sensemakers test the validity of their frames through engagement with peers or colleagues in an attempt to justify subjectively held beliefs. Expecting, on the other hand, denotes sensemakers' continuous efforts to relate their expectations of reality with experiences. In both cases beliefs form the basis or anchor for the sensemaking process. Importantly, the outcome of these processes often involves the updating of frames to maintain the plausibility of that which is experienced. In this way the sensemaker dynamically establishes a cue-frame relation or, stated differently, a justifiable understanding of what is occurring.

When sensemaking is driven by action, Weick argues, it generally takes one of two forms. Committing, refers to instances where the sensemaker takes irrevocable action and retrospectively constructs a meaningful understanding of that action. This form of sensemaking is particularly apparent when the action committed to is public and/or voluntary and the sensemaker has to construct a plausible justification retrospectively. Manipulation denotes sensemakers' active creation of the environment of which sense must be made. Weick emphasises this circularity by arguing that actions manipulate the environment and, in doing so, partly determine the reactions which follow. These reactions, in turn, form new cues for sensemaking. These continuous cycles of actor-environment engagement highlight the self-fulfilling nature of sensemaking processes, as actions are often taken to justify beliefs and beliefs are retrospectively updated to justify actions.

The sensemaking perspective offers "a powerful means of articulating and tracing the influence of information systems" by enabling the researcher to "explain and anticipate outcomes around technology" (Orlikowski & Gash, 1994, p. 201). In accordance with this view, this study frames the adoption of a computer-based ERP system as an occasion for sensemaking based on three key motivations: firstly, the adoption of an ERP system involves the redesign of existing organisational work systems. Users, as a consequence, are confronted with new or different task portfolios often imposed upon them by the artefact (Strong & Volkoff, 2010). This process not only triggers a steep organisational learning curve, but also influences the roles (and identities) of organisational actors (Ignatiadis & Nandhakumar, 2009). Secondly, ERP systems are technically complex phenomena likely to trigger various degrees of ambiguity and uncertainty about their nature and role in the organisation (Askenäs & Westelius, 2003; Jacobs & Weston, 2007; Soh & Sia, 2004). Finally, sensemaking is particularly well suited to the analysis of adoption as a social process during which user communities continuously and collaboratively construct shared frames of reference about artefacts (Orlikowski & Gash, 1994).

EXPERIENCES OF MISFIT AS CUES FOR SENSEMAKING

An important property of sensemaking, Weick argues, is that it is focused on and by extracted cues. The study of sensemaking, consequently, concerns itself with "ways people notice, extract cues, and embellish that which they extract" (Weick, 1995, p. 49). These cues form the focal points around which people "develop a larger sense of what may be occurring" (Weick, 1995, p. 50). Weick uses the metaphor of a seed to describe how cues play a "form-producing" role in the sensemaking process, guiding actors to link the concrete to the abstract within a specific context.

Previous research in IS has considered features of technological artefacts as cues for sensemaking. Griffith (1999), for example, argues that because proprietary ERP packages are technically complex phenomena it is idealistic to expect that users will form accurate understandings of entire artefacts. Rather, initial conceptualisations of a technology are formed by extracting and enlarging specific features of the technology as cues that trigger processes of subjective and intersubjective sensemaking. "Any technology is actually a combination (constellation) of features: distinct parts, aspects, and qualities. Features that are noticed by users then can be socially constructed into an organisational system" (Griffith, 1999, p. 473).

Askenäs and Westelius (2003), however, argue that the feature-based approach neglects the effect of the ERP's agency on the way it is constructed. To acknowledge this effect, they argue, users' constructions of the ERP should be considered in relation to their perceptions of "fit between the structure in the company and the IS functionality" on the one hand, and their perception of "how the system is trying to influence the user's work on the other hand" (Askenäs & Westelius, 2003, p. 210). Using these two dimensions they create four quadrants, each representing a metaphorical role (they add a fifth role for ERPs that have been rejected by the user community). The roles are described as:

- **Bureaucrat:** The ERP maintains the organisational structure and ensures that the enactment of structure conforms to rules. Users tend to accept this imposed structure if it fits their task portfolio.
- **Manipulator:** The ERP forces users to follow procedures that are experienced as unproductive or ineffective and align poorly with their requirements.
- **Consultant:** The ERP does not command work processes, but advises users when required. Users are able to manipulate the artefact to meet the requirements of non-standard use cases.
- **Administrative assistant:** The ERP is used for simple data-related tasks but does not control or enforce the organisation's processes or structure.
- **Dismissed:** A redundant ERP which has been dismissed by the user community.

Unlike the feature-based approach, the fit-based approach dictates that users' perceptions of a technology are dictated by their experiences of the application of the technology to achieve particular outcomes/goals. In doing so, it acknowledges that it is not the features themselves that users extract and enlarge, but the alignment between the features and users' requirements. In this study the fit-based approach is extended through the investigation of the role of particular experiences of misfit as cues for sensemaking of a technology.

Within IS the notion of fit has been addressed, both explicitly and implicitly, since the 1980s. Contributions to this body of literature have changed over time in response to the advancement of IT artefacts utilised in organisations. While early research of fit concerned correspondence between stand-alone, tool-like artefacts and single users, e.g., Goodhue and Thompson (1995), more recent research addresses organisation-artefact alignment as a separate level of concern (Sia & Soh, 2007; Soh & Sia, 2004; Strong & Volkoff, 2010).

Investigations of fit between individual users and particular IT artefacts typically focus on the premise that an individual's performance is influenced by "the correspondence between task requirements, individual abilities, and the functionality of the technology" (Goodhue & Thompson, 1995, p. 218). An experience of misfit, accordingly, may result from misalignment between any two of the three constructs. This dictates that misfit can exist even when the technological artefact offers all the required functionality – for example, when the user lacks the ability to utilise a particular function of the technology to complete a task.

Organisation-artefact alignment is not concerned with the individual user, but focuses on the degree of correspondence between the integrated work-flow framework of an integrated software system (like an ERP) and the organisational structures (which include policies, procedures and norms) of its adopter (Sia & Soh, 2007). The investigation of fit at this level of analysis is particularly important in the context of IS projects that involve the implementation of a commercial ERP package. Since such packages are developed for the broader market, they cover a generic requirement set which may differ substantially from that of adopters. Soh and Sia (2004) find that the requirements which commercial ERPs fail to address can be attributed to two sources. The first is voluntarily acquired organisational structures that include policies, procedures and norms which the organisation adopts on a voluntary basis. These structures typically result from strategies organisations employ to differentiate themselves from the competition. The second source of misalignment is industry-specific structures imposed upon the organisation by authorities (e.g., lawmakers or industry regulators).

Strong and Volkoff (2010) argue that, while organisation-artefact misalignment can be defined in terms of objective structures, instances thereof are subjectively experienced by users when ERP systems obstruct or complicate their work. They use grounded theory techniques in a qualitative case study to identify two primary categories of experience (deficiencies and impositions), which can be triggered by six categories of generative mechanisms. This enables the definition of twelve types of misfit experiences presented in Table 1.

While Strong and Volkoff (2010) investigate the antecedents of misfit, this study takes interest in its consequences. It is proposed, in particular, that experiences of misfit prompt users of ERP systems to engage in sensemaking. Three primary motivations support this proposition. Firstly, because experiences of misfit obstruct work processes, users are prompted to cope with or overcome them through some form of cognitive or behavioural adaptation (Beaudry & Pinsonneault, 2005). Secondly, the integrated nature of ERP systems implies that experiences of misfit are

often shared by users working within the same or similar business processes. It is expected, accordingly, that these experiences will spawn conversation (argumentation) about the nature, role and functions of the technology (Bansler & Havn, 2006). Finally, experiences of misfit may illustrate to users the shortcomings or limitations of the ERP artefact. Users, consequently, are expected to update their frames of the technology when they gain awareness of its deficiencies.

TABLE 1: STRONG AND VOLKOFF'S (2010) TYPOLOGY OF EXPERIENCES OF ORGANISATION-ARTEFACT MISALIGNMENT

Generative mechanism	Description	Experienced as deficiency	Experienced as imposition
Functionality misfit	The reduction of process efficiency due to artefact adoption.	When artefact functionalities require work-arounds to complete tasks.	When integration or standardisation embedded in the artefact is incongruent with that required by interdependent business processes.
Data misfit	Data or data characteristics stored in or needed by the ES lead to data quality issues such as inaccuracy, inconsistent representations, inaccessibility, lack of timeliness, or inappropriateness for users' contexts.	When there are too few attributes or levels of data associated with certain entities or the software fails to support relationships between entities.	When integration and standardisation between different business units requires the alignment of entity definitions, which leads to imposed generalisation of entities.
Usability misfit	Interactions with the artefact required for task execution are experienced as cumbersome or confusing.	When the artefact's user interfaces are poorly designed for data capture (e.g., forms and fields) or presentation (e.g., reports).	When integration of application areas in the artefact leads to large, complex data sets and more effort is required to locate relevant data.
Role misfit	Roles in the artefact are inconsistent with the skills available, creating imbalances in the workload, bottlenecks, idle time and mismatches between responsibility and authority.	When it is not possible to set up roles with the desired locus of accountability within the ES.	When integration or standardisation embedded in the artefact impacts the roles and responsibilities defined in organisational structure by changing skills required in roles, workloads, authority required in roles, etc.
Control misfit	The controls embedded in the artefact provide too much control, inhibiting productivity, or too little control, leading to the inability to assess or monitor performance appropriately.	When the artefact forces the application of standard rules to instances where a business process presents an exception to the rule.	When rules embedded in the artefact make diversions from typical business process flow impossible.
Organisational culture misfit	The artefact requires ways of operating that contravene organisational norms, such norms, in turn, may be embedded in a broader (e.g., national) culture type.	Due to its holistic nature, emerging from the totality of the technology and its context, misfits from this source are only experienced as impositions.	When actors are required to contravene organisational norms by acting in obedience to rules imposed by the artefact.

RESEARCH DESIGN

To investigate the proposition that experiences of misfit act as cues for sensemaking of ERP technology an empirical investigation was performed in March 2013. The empirical investigation took the form of a single, cross-sectional case study during which the researcher aimed to gain an in-depth understanding of the adoption/adaptation process through multiple data collection techniques. Case studies enable researchers to investigate not only the IT artefact itself, but the range of phenomena (culture, style of management, role hierarchies, etc.) that form the organisational context in which technological artefacts are embedded (Avison & Pries-Heje, 2005; Yin, 2009). The vast majority of investigations in this line of IS research, accordingly, utilise case study design (with qualitative methods) to collect "a full variety of evidence", which may include interviews, documentation and artefacts (Yin, 2009, p. 11).

The case organisation is one of South Africa's nine metropolitan municipalities, referred to using the pseudonym *Metro*. A variety of data collection techniques were utilised, including the analysis of public reports on local government; the analysis of *Metro's* internal documentation (policies, standard operating procedures, workflow diagrams, role hierarchies, forms etc.); interviews with directors; a survey completed by more than 800 ERP users; a group interview with members of the ERP project steering committee; and, finally, one-on-one interviews with 24 users in the supply chain management (SCM) department. These techniques were used in an iterative manner enabling the researcher to design data collection instruments based on the analysis of data previously collected. For the purpose of this article focus falls on the interviews conducted with users. However, data collected through other techniques is utilised here to enable description of the users' organisational context.

Interviews were conducted with 24 individuals from three branches in the SCM Department. The individuals were selected based on an analysis of their roles (task portfolio) with emphasis on the degree to which their tasks involved interaction with the ERP.

TABLE 2: THE BRANCHES (UNITS) AND ROLES OF INTERVIEWEES WITHIN THE SCM DEPARTMENT

Branch	Role	Number of interviewees
Procurement	Team Leader	3
	Buyer	5
	Assistant buyer	5
Tenders and contracts	Practitioner	1
	Professional officer	1
	Admin officer	2
	Clerk 3	1
	Clerk 2	2
	Support staff	1
Supplier management	Clerk 3	2
	Head	1
Total		**24**

During each interview questions were asked about the participant's role at *Metro,* how they used the ERP system, their general views on the system, and their experiences of and problems working with the system. For each problem identified, participants were asked to describe the problem, what they did when it happened, how they learned to handle the problem in that manner, and any problems that may have subsequently resulted from that way of doing things (refer Apppendix A). The interviewer, based on responses from the interviewee, asked more specific questions where required. To avoid confusion the interviewer did not use sensemaking terminology (e.g., frames or cues) during the interviews, more general terms like "view", "understanding" or "perception" were used. All the interviews were recorded using a digital dictaphone and the researcher made field notes after completing an interview to summarise the key aspects thereof.

Analysis of the interviews was informed by Weick's theory of sensemaking and earlier findings about experiences of misfit and sensemaking of technologies. The framework dictates, firstly, that an experience of misfit denotes one of two scenarios: The first scenario includes cases where, due to a lack of knowledge of the technology, the user is unable to achieve a task outcome (i.e., user-technology misfit due to individual abilities). The second scenario includes cases where the user's performance is obstructed or impeded due to an instance of artefact-organisation misalignment. The two forms of experience, the framework proposes, will impact user performance by either obstructing completion of a task or negatively impacting task efficiency. It is further proposed that this will trigger behavioural responses among users that can be analysed as forms of technology sensemaking. The framework does not propose predefined categories or types of behavioural responses.

Application of the framework followed five steps:

1. All the interviews were analysed by a single researcher (the author) to identify particular experiences of misfit as the primary units of analysis.
2. Each experience of misfit was then analysed further based on the following principles:
    a. The experience was categorised as an instance of user ignorance if it resulted from the user's self-reported inability (lack of knowledge) to utilise the artefact's features correctly to achieve task outcomes.
    b. The experience was marked as an instance of task-technology misfit and categorised according to Strong and Volkoff's (2010) typology (see Table 1), if it resulted from an instance of artefact-organisation misalignment.
    c. The user's response to the experience was analysed and framed as a form of sensemaking as described in section 2.

CASE BACKGROUND

Metropolitan municipalities, much like large private sector organisations, have been under increasing pressure to leverage the capacity of IT artefacts to improve performance. Following general global trends South African metropolitan municipalities (metros) have expanded considerably over the last four decades due to urbanisation and in-migration. This process has placed extensive pressure on the resources available to metros as the demand for the expansion of service delivery steadily climbs. Particularly challenging in this regard has been the rapid growth of informal settlements around metropolitan areas, as homeless, and often jobless, citizens migrate closer to the urban centres in the hope of improving their standard of living (Department of Cooperative Governance and Traditional Affairs, Republic of South Africa [COGTA], 2009, p. 39). Unemployment levels in metros range between 26% and 50% (COGTA, p. 23). Apart from these challenges the size of metros also implies that they require "more sophisticated urban management capacity and skills to deal with spatial planning, land-use management and infrastructure life-cycle management" (COGTA, p. 22).

Metro was established as one of South Africa's metropolitan municipalities following municipal elections in 2000. The process involved the amalgamation of seven previously autonomous municipalities under a single local authority. It has a workforce of just over 30,000 people and is responsible for the delivery of municipal services to around 3,5 million citizens spread over an area of 2,500 km2. As a local government organisation *Metro* is governed by a legislative council elected through municipal elections. The council at the time of the investigation was elected in 2011 and consisted of 221 seats. The council elects, from its membership, a mayor who is appointed as the head of the municipality's executive structure. The mayor, in turn, appoints a 12-member council representing the organisation's 12 directorates. Each directorate is managed by an executive director and divided into various functional departments. *Metro's* largest directorate (Finance) has 10 departments while the smallest (Social Development and Early Childhood Development) has two.

As a major part of its establishment *Metro* faced the challenge of integrating more than 100 smaller, fragmented legacy systems used throughout the municipalities that were amalgamated. Based on a high-level requirements analysis process the organisation realised the need for a large, integrated solution and a decision was made to implement a proprietary package. Following this decision *Metro*, in consultation with Gartner Research, initiated a rigorous selection process to identify the most suitable supplier. The process involved over 250 members of staff (mainly senior and middle management) and culminated in the selection of an international supplier. The supplier had limited experience in the implementation of their product in local government contexts and the implementation within *Metro* posed a significant challenge - the project was labelled as the largest of its kind (i.e., local government implementation) ever undertaken.

The first phase of the project life-cycle involved a four-month analysis and design process with the aim of ensuring alignment of the ERP with *Metro*'s requirement set. The second phase involved the implementation of the accounting, procurement, materials management and human resources functionality and was completed in 10 months. The final phase of the project involved the release of more functionality and was completed by mid-2003.

While *Metro* initially faced quite a lot of criticism for the project, mainly due to the costs involved, it was widely hailed as a success after the organisation reported a 14% rise in income generated through billing from 2004 to 2005. This improvement contributed to the improvement and integration of *Metro*'s information management processes through the ERP implementation projects. The return on investment meant that the project effectively covered its own costs in the two years following implementation and future gains could be utilised to improve service delivery.

Because of its size (over 30,000 employees) the collection of qualitative data across all *Metro*'s functions was unfeasible. The researcher consequently decided to select a particular functional area for investigation. The decision was dictated, firstly, by the degree to which the ERP was integrated with organisational work systems in the functional area and, secondly, by the key challenges identified by the AGSA's (Auditor General of South Africa's) reports on local governance in South Africa (Auditor General of South Africa, 2011, 2012). Following an investigation of the AGSA's reports and meetings with the relevant directors at *Metro*, a decision was made to perform data collection within *Metro*'s SCM department.

Chapter 11 of the MFMA sets out the regulations for SCM in municipalities. These regulations aim to ensure that "procurement processes, contract management and the controls in place to ensure a fair, equitable, transparent, competitive and cost-effective SCM system that complies with legislation and that minimises the likelihood of fraud, corruption, favouritism as well as unfair and irregular practices" (Auditor General of South Africa, 2011, p. 70). Given the general poor state of financial management within South African municipalities, it is not surprising that the implementation of the SCM policy has been dismal. The AGSA reports that, for the 2009-10 financial year, irregular spending by municipalities was almost always a result of the contravention of the SCM policy and legislation, accounting for 94% (R3,9 billion) of all irregular municipal expenditure. This figure increased to 98% (R6 billion) in the 2010/11 financial year (Auditor General of South Africa, 2012).

On average *Metro* handles close to 30,000 supply-chain transactions every month. The bulk of these transactions involves the utilisation of contracts for the supply of products which *Metro* requires on a regular basis. Once such a contract has been awarded to a supplier, following the formal bidding process and the specification of an item's cost, the organisation can bypass the time-consuming processes of collecting and adjudicating quotations for a large part of these transactions. The routine nature of such transactions makes them well suited to computerisation, and *Metro* utilises its ERP extensively in this area of business. However, in accordance with MFMA regulations, a competitive bidding process must be followed when demands exceeding R200,000 are processed. The unique nature of each tender complicates the application of the ERP in this process, as *Metro*'s Director of IST (Information Systems and Technology) explained:

> It's technically one-offs so why configure this whole thing for a special road? So I think we have got to be very careful to think to what extent we want to automate this and always ask ourselves is this really going to be, in the long run, the right thing to do. To ask a system to automatically do the adjudication for you on the big-end tenders is probably asking too much and would actually create more problems than benefits.

To cater for such cases the SCM Department, while using the ERP system extensively, also developed various manual (paper-based) workflows to process high-value transactions and a collection of contingencies.

DISCUSSION OF FINDINGS: FOUR BEHAVIOURAL STRATEGIES TO MAKE SENSE

From the interviews the researcher identified and analysed 34 experiences of misfit. The categorisation of these cases involved the analysis of the generative mechanisms of each in accordance with the principles applied by Strong and Volkoff (2010). While many of the cases clearly fell within one of the prescribed categories, some required careful, systematic analysis to justify categorisation and ensure consistency. An example is a case where a user could not complete a task because data were not captured completely at a previous point in the workflow. While it seems, prima facie, that the user experienced an instance of data deficiency, the data capture error (as opposed to a technological deficiency) is the generative mechanism of misfit. Furthermore, the data capture error may itself have resulted from an earlier experience of misfit (e.g., usability misfit). To ensure consistency across the analysis the researcher categorised each experience in accordance with the user's interpretation of the generative mechanism. This decision was motivated by the argument that the user's response to misfit should be considered in relation to his/her understanding thereof, as opposed to an objective analysis of the chain of events preceding it. While this approach enabled consistency in the analysis process, it should be noted that an objective analysis of multiple data sources afforded the researcher a more accurate view of the various misfit instances. For the purpose of this study, however, interest falls on the manner in which users developed plausible (as opposed to accurate) understandings of their experiences. Le Roux (2013) presents a detailed analysis of the full body of empirical evidence collected at *Metro*.

Of the 34 experiences, 17 experiences were attributed to instances of organisation-artefact misalignment, 15 experiences were attributed to user abilities and two experiences were attributed to technical (hardware) deficiencies. The 17 instances of organisation-artefact misalignment included

- seven cases of control misfit (three deficiencies and four impositions);
- three cases of role misfit (all impositions);
- three cases of usability misfit (all deficiencies);
- two cases of data misfit (both deficiencies); and
- two cases of functional misfit (both deficiencies).

In seven of the 15 cases attributed to user abilities, the user admitted that the experience resulted from his/her own lack of knowledge about the system features. In the other eight cases, however, users attributed their experience of misfit to the abilities (or lack thereof) of a user capturing or processing data at an earlier point in the workflow.

Experiences of misfit affected users' task performance in two primary ways. In 24 of the analysed experiences the user could not complete the task at hand until the problem was resolved. In these cases misfit obstructed the workflow and, in doing so, forced the user to take some form of action to overcome the problem. In the remaining 10 cases misfit impacted the user's performance, primarily by inhibiting his/her ability to achieve task outcomes efficiently. In such cases the user could achieve the task outcomes, but in a manner perceived as tedious and/or frustrating.

Initial analysis of the data revealed that users responded to misfit by employing a variety of strategies. After further analysis these strategies were reduced to four general types. In the sections which follow, each of these strategy types are discussed with reference to particular examples and analysed as a form of sensemaking.

STRATEGY 1: USER CONFRONTATION

The response strategy adopted in 12 of the 34 cases is referred to as "user confrontation" and involves the user confronting (mostly telephonically or via email) another user. This strategy was adopted in all cases where users attributed their own experience of misfit to the abilities of another user. It was also adopted in response to three experiences of control misfit and one of role misfit. While this form of confrontation may involve undesired conflict among users, it acts as a form of informal user training during which acceptable usage norms are made explicit and errors pointed out and resolved. The following interview excerpts provide examples of users describing confrontation.

> "So, I phoned the lady and said to her I'm sick and tired, can't you people think for yourselves, you can see there is an address field. And she said can't I be a bit nicer. So I say I've been saying this a hundred million times, I don't think being nice will work anymore."

> "I still have to explain things to my buyers, every day, because each has a different setup to work with, each tender is different. I get frustrated after a while, anyone would, but I've learnt to relax and handle each one on its own merits."

> "One day I saw a requisition come through for an item that is on tender and it was for R1! And I called them and said what the hell are you doing? If you work like that we can just get people off the streets to do your job. How can you release a requisition for R1? And these are senior people!"

Instances of confrontation are analysable as action-driven sensemaking processes. While they generally result in argumentation (belief-driven sensemaking), the action of confronting another user is not undertaken with the aim of establishing frame validity. It is, rather, an attempt to manipulate the environment through the establishment of usage norms with the aim of, in Weickian terms, consolidating that which is real. In this context the user's environment is inter-organisational and continuously shaped and reshaped by the actions of other users sharing the same integrated software artefact. By manipulating the usage behaviour of others through confrontation users

actively create the environment in which they work. The goal of confrontation, then, is to establish correspondence between the user's beliefs about desirable ERP operation and his/her reality.

STRATEGY 2: WORK AROUND

In 11 of the 34 cases users adopted a workaround in response to the experience of misfit. Despite various calls for research into workaround practices (Kellogg, Orlikowski, & Yates, 2006; Orlikowski & Gash, 2011), this area of IS remains notably under-researched (Azad & King, 2008; Ignatiadis & Nandhakumar, 2009; Pollock, 2005). "IS researchers have generally focused their theoretical energies on the intended use of information systems, devoting much less attention to computer workarounds" (Azad & King, 2008, p. 264).

In all the instances where workarounds were adopted at *Metro*, it was done in response to an instance of organisation-artefact misalignment. Three scenarios were evident. In the first, users required certain data to which they did not have access through the ERP (role/control misfit experienced as imposition). To obtain the data users contacted a colleague who did have access to the data and requested that it be exported and sent to them via email. In the second, users needed to compile reports for particular stakeholder groups. While they were able to utilise the ERP's built-in reporting functionality, the resulting reports either lacked certain data or contained too much data (data misfit experienced as deficiency). Users responded to such instances by extracting the data from the ERP to a spreadsheet and manipulating the output to develop the desired report. In the third scenario certain requirements of a business case were not catered for by the ERP functionality (functional misfit experienced as deficiency) and required users to follow a manual (paper-based) workflow.

From a sensemaking perspective, these experiences of misfit play two important roles. In cases where the instance of misfit was experienced as an imposition the role of the ERP as imposer of data access control became illuminated. This is evident from the following explanation given by an interviewee:

> We e-mail [data to colleagues] a lot – especially to people without access. And I've asked [the developers] why it is like that? I think it has to do with combating corruption. They prefer that the project manager on site does not work on [the ERP] – so that he can't have access to give work to his friends.

While users understood the ERP as a tool to increase organisational efficiency, experiences of misfit such as this led them to make sense of the ERP as playing the role of an auditor enforcing adherence to internal policy and legislation. In instances where the business case required the adoption of a manual workflow, the bureaucratic nature of the artefact became illuminated. At *Metro* certain circumstance justified the placement of an emergency/urgent purchase order which allowed users to bypass the ERP and place the order telephonically to the buyer. One user explained:

> When there are urgent purchases that need to be made the relevant person will contact the buyers and inform him that it's an emergency or urgent matter. The buyer will allow the purchase order but first thing in the morning he will want all the relevant documentation from the department to process it in the [ERP].

In the example above, the experience of misfit serves as a cue which makes the role of the ERP as bureaucrat sensible. It also reveals, contradictorily, the inability of the ERP to, firstly, determine/judge whether a particular business case may be classified as urgent or an emergency and, secondly, to disregard its built-in rules if this is the case. Consequently, while users do construct the ERP as an active role-player as suggested by Askenäs and Westelius (2003), the experience of misfit serves as a cue which highlights its rigid, non-human nature.

Like user confrontation, the creation and adoption of work-arounds constitutes active manipulation of the environment. Such manipulation offers users a sense of control over the environment and, in particular, the artefact. The existence of these practices blurs the traditional user-system boundary and cultivates, rather, an image of the information system as continuously enacted through iterative cycles of environment perception and manipulation. This view embraces the notion of information systems as complex, adaptive, socio-technical systems.

STRATEGY 3: IMPROVISED LEARNING

In six of the 34 cases, the user experiencing misfit approached a colleague from his/her own unit/department for advice or support. Boudreau and Robey (2005, p. 9) refer to this practice as improvised learning and define it as "learning situated in practice, initiated by users, and implemented without any predetermined structure, schedule, or method". In all six cases users adopted this strategy when they attributed their experience of misfit to their own lack of knowledge of the ERP's structure and functions. One user explained:

> I had in-house training when I started at [*Metro*] for a week. But most of it, well, it's that you have to want to learn. So if you have an accounts payable query and you don't know how to handle it, you get up and you walk to someone and say 'Please help me, I don't know how to do this'. So that next time you can do it on your own. So, yes, most of it was self-taught.

As a form of sensemaking, improvised learning, in a similar way to user confrontation, involves engagement among users about the application of the ERP in a particular business scenario. Unlike user confrontation, however, improvised learning is initiated by the user acknowledging his own lack of knowledge/ability and generally occurs among users that share the same unit or department. This enables rich (face-to-face) interaction between users that,

based on the cases analysed, share a relationship of mutual trust. While interviewees were mostly positive about this practice, they were aware that overreliance on colleagues was undesirable. One user explained:

> You know when you just start in a new unit you get the feeling that you're not yet accepted there. Then it is difficult to ask 'Sorry, I'm stuck, can you please help me?' At some stage people will get bored with coming and helping you. Because she'll come and explain it to me but as I'm going along I get stuck because I can't remember everything she said. Now if I go and ask again, what is she going to think of me? It depends with people, some people will help, and others won't.

An important effect of improvised learning is that it facilitates frame alignment and shared usage norms among users. Through continuous engagement about the functions and role of the ERP, increasingly rich and meaningful shared frames of the technology can be expected to emerge (Bansler & Havn, 2006). Users, through this practice, make the technology sensible to each other in a manner that is relevant and applicable to their shared context.

It is important to acknowledge, once more, the active role of the user in improvised learning. By seeking guidance from co-workers (taking action) the user actively generates cues around which sense can be made. Weick emphasises this aspect of sensemaking by distinguishing it from interpretation, which, he argues, frames the sensemaker as a passive perceiver of external stimuli. The sensemaking process (improvised learning) commences with action which, in turn, generates sensible stimuli.

STRATEGY 4: FORMAL SUPPORT

In the remaining six cases of misfit users utilised a formal support channel (e.g., contact the help desk or attend a training session). In two of these cases the experiences were results of technical/hardware problems, in two more they resulted from the user's own lack of knowledge/ability and, in the remaining two cases, the experience could be attributed to instances of organisation-artefact misalignment (control misfit experienced as deficiencies).

While *Metro* did implement an extensive formal training programme for users, many of the interviewees felt that improvised learning was a more effective practice.

> The problem is there are a lot of new things coming out on [the ERP] all the time. There isn't enough time to train everyone. They might train us, but they can't train all the people that must use it out there. We usually learn things by ear – 'How do you use this, how do you use that?' But [at formal training] there is no time to do that.

The findings suggest that the advantage improvised learning has over formal training is that it occurs in relation to an experience of misfit. While formal training presents users with the acceptable usage norms in a simulated environment, improvised learning is triggered by a particular experience. When users opted to utilise formal support when they experienced misfit the support staff were often unable to resolve the problem immediately.

> For example, last year I had this problem where the system changed for all repairs and maintenance items. You had to do a works order but I think management were informed of the change but we, at lower levels, didn't know. We constantly experienced problems when we tried to put through a purchase requisition. I logged the call but they couldn't assist me in the beginning. Then, after about two months I had the same problem and I logged the call again. Eventually somebody came back to me to [explain the problem].

The data suggest that users mostly perceived instances of misfit to be context-specific, prompting them to seek advice from a person who was familiar with the acceptable usage norms of that context. There is little evidence, accordingly, to support the proposition that the use of formal support channels in response to experiences of misfit is conducive to making a technology sensible to users.

CONCLUSIONS

Based on a qualitative investigation of data gathered through semi-structured interviews it is argued that experiences of misfit trigger various forms of response strategies among users. Of the four strategy types identified three can be viewed as forms of action-driven sensemaking. These include the confrontation of users that do not follow acceptable usage norms; the adoption of workaround practices; and the adoption of improvised learning practices.

Three primary arguments emerging from the analysed data support the proposition that experiences of misfit trigger sensemaking. These four arguments establish linkages between the properties of sensemaking in organisations as described by Weick (1995) and the analysed data. Firstly, the findings show that experiences of misfit are disruptive of users' work. In 24 of the analysed cases the user experiencing misfit could not complete the task at hand. These disruptions force users to pay attention and construct plausible explanations of the experience upon which they can act. Importantly, the nature of ERP facilitated workflow implies that users cannot ignore these disruptions, since a transaction allocated, but ignored, will draw attention from a supervisor or line manager. Secondly, it is argued that users' extract and enlarge experiences of misfit retrospectively.

The data revealed that users' recollections of misfit experiences are rich in detail and typically involve reasoning about the underlying causalities. This suggests that these experiences have been bracketed out from ongoing streams of experience and reflected upon critically. Thirdly, the study provides strong evidence that responses to misfit are, in most cases, of a social nature. In 23 of the cases analysed users either confronted a co-worker (12 cases) or consulted a co-worker (11 cases). These behavioural patterns constitute action-driven sensemaking processes during which users either manipulate (enact) their environment or actively generate stimuli to reduce ambiguity/uncertainty.

While this study focussed on experiences of misfit, it may be proposed that experiences of fit can play a similar role, particularly when users successfully apply a technology in a new or unique scenario. These user success stories, it is argued, also have the potential to trigger sensemaking when they are extracted and discussed.

Finally, it is worth reflecting about the implications of these findings for practice. While this study is of a descriptive nature, practitioners may find value in these findings in three ways. Firstly, it is important to note that in only six of the 34 cases experiences of misfit triggered the use of a formal support channel. Hence, while IS/IT departments may use logs of support requests as indicators of fit achieved, they should be careful to rely too heavily on them. This study suggests that by far the most (28 of 34) cases of misfit experienced are handled informally among users. Secondly, the findings suggest that formal training programmes are limited in their ability to stimulate sensemaking. While an obvious necessity, it seems that users learn more effectively from improvised, informal engagement in response to misfit experienced than from formally designed training courses. Lastly, the value of an organisational culture that supports and cultivates informal learning should be highlighted. IS/IT departments should, in combination with formal support/training, encourage informal learning practices. This may involve interventions which, for example, recognise or reward individuals that frequently adopt the role of informal trainer in a particular department.

LIMITATIONS AND FUTURE RESEARCH

While ERP-based information systems satisfy a significant set of the characteristics of general business information systems, one should be mindful of their unique attributes when framed as targets of sensemaking. Three attributes, in particular, must be noted. Firstly, the integrated nature of ERPs implies that adoption by users is generally mandatory. Secondly, ERPs are designed to impose task/process structure and, thirdly, ERP usage emphasises task-interdependence. Combined, these attributes serve to drive the adaption process and, as part thereof, subjective and shared technological sensemaking. Weick's theory of sensemaking may indeed be relevant/applicable to a wider range of technology adoption projects, but the findings of this study relate strongly to the unique attributes of ERP artefacts. The adoption of IT artefacts for hedonic purposes, for example, is driven by different forces and may, in turn, lead to different sensemaking processes. A second notable limitation of this study is that it is concerned primarily with sensemaking by the user community. An investigation of the sensemaking processes that occur, for example, among members of IT/IS departments during adaptation is likely to uncover different findings. A final limitation worth noting is that the author performed the analysis without assistance, an arrangement that may have obstructed the objective interpretation of the data.

Despite these limitations, future research projects can build upon this study in various ways. It has been shown here that Weick's theory of sensemaking provides researchers with a useful analytic and conceptual framework to interpret action-driven technology sensemaking. This provides researchers with an alternative to traditional adoption models and illuminates the cognitive and social dimensions of (non-linear) adaptation processes. Importantly, it also provides a basis for the reconceptualisation of the user-system boundary by acknowledging the user's role in the manipulation of his/her environment.

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APPENDIX A

Outline of interview questions.

1. Please give us a brief overview of your role and its associated tasks at *Metro*.
2. How do you use the ERP system during these tasks?
3. What is your general view of the ERP system?
4. Do you experience any problems or issues when working with the ERP system?
   a. Could you describe one?
   b. What do you do when this happens?
   c. How did you learn to handle it this way?
   d. Are there any problems which result from this way of doing things?

FROM INFORMATION TO ENGAGEMENT: EXPLORING COMMUNICATION PLATFORMS FOR THE GOVERNMENT-CITIZEN INTERFACE IN SOUTH AFRICA

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ABSTRACT
An effective communication interface between government and citizens can strengthen government responsiveness and deepen citizen engagement. Such communication and information exchange takes many formats, especially given the various platforms and technologies available. This article situates communication options and strategies in the context of: reported challenges around engagement practices; expressed public preferences for particular communication platforms; and existing barriers to ICTs and other infrastructures in South Africa. Using both qualitative and quantitative data, the research reported here explores two questions: What are the most suitable platforms to improve government-citizen communication in South Africa? How could ICTs and other platforms be better used to promote improved communication and more meaningful citizen engagement around public services? We argue for a differentiated approach to communicating with citizens that acknowledges social realities and preferences if technology is to benefit socio-economic processes in a democratic South Africa.

KEYWORDS
ICT-mediated communication, government-citizen interface, public engagement, smart cities

INTRODUCTION

Local government in South Africa is mandated to deliver services and infrastructure, as well as to engage the public in its various governance processes. This requires government to communicate to residents on key matters, from broader planning and policy decisions to where and how they can resolve basic service issues (e.g., where to pay, how to report faults, etc.). Mechanisms that enable the exchange of information play a critical role in strengthening deeper community engagement. While the sharing of information is not in itself a sufficient method of engagement, such mechanisms are often seen as the "foundation" thereof (Svara & Denhardt, 2010: p. 11). The South African National Department of Communications has, for instance, described communication as "the main driving force to [sic] which a relationship between the citizens and local government can be fostered" (Muthambi, 2014). It is also often through information exchange that citizens[1] express their "voice" (preferences and opinions) against which government responsiveness and accountability can be measured (UN-Habitat, 2009: p. 93).

Currently there appears to be a dearth of sufficient information exchange between local municipalities and residents in South Africa. The diverse composition of communities, and particularly high levels of poverty and inequality, makes it difficult for local government to understand and meet the needs of all residents. Such differences in experience and resources require different information-gathering, communication and engagement approaches. Conventional participation mechanisms are also plagued by numerous constraints that have been widely acknowledged across the literature. Some scholars, for example, highlight the exclusion of certain groups, especially the poor (Masiko-Kambala, Gorgens & Van Donk, 2012). This is problematic given the country's history of marginalisation, as well as the importance of inclusiveness for strengthening governance and accountability (World Bank, 2004). Furthermore, citizens and communities often lack knowledge about government policies, budgets and operations, mechanisms for engagement, or even their own rights and responsibilities (Malabela & Ally, 2011).

The aim here is to answer two questions: What are the most suitable platforms to improve government-citizen communication in the country? How could ICTs and other platforms be better used to promote substantive engagement around public services? Understanding which are the most suitable channels to reach particular segments of the population can help to overcome existing knowledge gaps through better, targeted approaches. The emergence of information communication technologies (ICTs) and the future potential of the so-called smart city agenda, which mobilises ICT infrastructure for sustainable development and human well-being (Deloitte 2014: p. 3), also raises the question whether these provide adequate tools for communication and engagement.

This article examines qualitative data from in-depth interviews with municipal officials, academics and civil society stakeholders on current engagement processes. It also looks at national quantitative data on public preferences

1 We use the terms "citizen", "resident", and "community" interchangeably to refer to any individuals residing in the country who make use of services and who could participate in some shape or form in the exchange of information with government.

for the use of different media to receive communications from government. The Human Sciences Research Council (HSRC) conducted the research in 2013-2014 as part of the Cities Support Programme (CSP) led by National Treasury. The quantitative data were collected under the 2013 South African Social Attitudes Survey (SASAS), and examined a range of platforms, from television and radio to print media, electronic media, and face-to-face interaction. Although it is beyond the scope of this article to examine the diversity of media within each of these platforms, the article sheds light on the overall role and potential of the various platforms, and of ICTs in general vis-à-vis older communication tools. It is also in relation to the concerns and challenges with the government-citizen interface, as identified in the qualitative interviews, that the role and potential of communication platforms must be understood.

The article begins by setting out the conceptual framework of "participation". It then reviews communication and engagement mechanisms in South Africa, which includes a growing use of ICTs. The emerging discourse of smart cities is then discussed, particularly in relation to the future potential of this development path for strengthening citizen engagement and overcoming the digital divide. Thereafter the results from the qualitative research reveal key challenges with existing processes of interaction. These form the basis for understanding public preferences for different communication platforms (as expressed through the quantitative data), as well as the potential of these platforms to strengthen the government-citizen interface.

FROM COMMUNICATION TO ENGAGEMENT: A CONCEPTUAL FRAMEWORK

In South Africa, public participation is a widely recognised aspect of democracy and governance. It is entrenched in the 1996 Constitution and is captured in various institutional, policy, and law-making processes, as well as in the establishment of statutory bodies, structures and programmes (Booysen, 2009). The term encompasses a range of objectives and mechanisms, including communication as information exchange, on the one hand, and participation as substantive engagement in service delivery and development on the other. The former includes one-way communication channels where a municipality either provides or obtains information (e.g., billboards, newspapers, road shows, websites, surveys, petitions, public dialogues, etc.). The latter refers to the involvement of citizens in actual decision-making, the co-production of services, or oversight of service delivery and government performance. In this view, "engagement" is distinct from participation insofar as it refers to a kind of "co-governance" that views citizens as active, empowered partners rather than passive recipients of services (National Planning Commission, 2011). It is often described by scholars as "meaningful" or "transformative" engagement (Chenwi & Tissington, 2010), and is called for in the wake of generally ineffective efforts to bring citizens directly into governance processes.

This framework resonates with that of the Global Report on Human Settlements (UN-Habitat, 2009: p. 94), which distinguishes forms of participation along a continuum from so-called nominal participation to consultative, instrumental, representative and transformative engagement. Each form is associated with a different intended purpose that requires particular methods of implementation. These purposes include window-dressing, acquiring or giving information, enhancing effectiveness, providing a space for the expression of preferences, empowering citizens, or fostering engagement as an end in itself. This framework is also similar to participation categories applied in South Africa (see for example DPLG, 2007; CMRA, 2011).

There is value in each of these levels or typologies of participation, from consultation "upwards". Despite their different objectives, each remains within the broader framework of participation and should ideally support the realisation of transformative engagement. In this way, "consultation" may comprise exchange of information relevant to the provision and maintenance of services. But it should also contribute towards strengthening the relationship between government and citizens, and support opportunities for more substantive interactions and decision-making. The outcomes of transformative engagement furthermore feed back into other mechanisms: through strengthened relationships based on trust and good will, citizens become more likely to use and value other platforms such as complaints systems or satisfaction surveys. The full potential of engagement is therefore realised not simply at the transformative level, but throughout the system of diverse yet complementary interactions.

In light of this conceptual framework, it is necessary to consider experiences and barriers of the broader engagement context when examining communication options. Likewise, in order to strengthen engagement, it is important also to examine communication approaches in so far as these provide an important base for further dialogue and decision-making. One could thus ask how processes of information exchange may be designed and used in such a way that they carry one "upwards" along the participation continuum. In the next section, we look at common participation and communication mechanisms, especially ICTs, in South Africa.

GOVERNMENT-CITIZEN COMMUNICATION CHANNELS IN SOUTH AFRICA

The South African government uses a variety of platforms nationally and locally to provide information to, as well as receive information from, individual residents and communities. These include mass communications through television, newspapers and radio, which are the most popular means of passing information to people due to their wide reach (Andani & Naidu, 2013). Government also makes use of several platforms that enable direct communication, intended rather as forms of engagement. Such face-to-face processes often take the form of public meetings (for example, imbizos, "Exco meets the people" and citizen forums), and/or operate through particular structures (for example, ward committees, budget fora and community development workers).

Ward committees in particular are the key participatory structures for local government. In practice, these have not proved as functional and effective as expected. Challenges range from lack of appropriate skills and resources of committee members to party politicisation, limited decision-making power of councillors, and limited community knowledge of ward committee functions and responsibilities. These issues have received considerable treatment in the scholarship and therefore will not be replicated here (Piper & Deacon, 2008; Malabela & Ally, 2011; Cowell, Downe, Martin & Chen, 2012). Suffice it to say that direct engagement through ward committees generally does not provide a sufficient channel for either providing information on government services or fostering relationships between government and citizens.

With the advent of information technologies,[1] new opportunities for communication are also emerging. These range from municipal websites to mobile applications and social media platforms like Facebook and Twitter. Citizens and government have both increasingly started to use these tools to communicate and interact with one another. Government efforts to expand access to ICTs, and to market government services through ICTs, especially into rural areas, have largely taken the form of community centres called Thusong Service Centres (TSC) or Digital Community Hubs (DCHs) (Kariuki, 2009). These provide computers for people to access information related to business, government, education, banking, etc.; they are also expected to "enhance the capacity of communities in utilizing ICTs" (Kariuki, 2010).

In the urban areas, some of the metros are exploring the potential of mobile applications (or "apps") for a range of matters, including reporting road-related problems (e.g., Johannesburg Road Agency), calling for police support in case of emergency (e.g., City of Tshwane), or using a single portal to access municipal accounts, receive alerts, lodge complaints, and report problems (e.g., eThekwini municipality). Various non-governmental apps and platforms have also been released (e.g., GridWatch, which keeps citizens informed about load shedding schedules). Despite the proliferation of such tools, it is the extent of their usage that signals their importance and impact. Although beyond the scope of this article, a comparison of the use of government versus non-government apps may be indicative of government strategy and the potential of such tools to impact government-citizen relations.

These developments may also be seen as part of a broader global trend towards the creation of smart cities: local governance systems where technology is the cornerstone for providing and operating services. Cities like Shanghai, Singapore, Brisbane and Ottawa are, among others, at the forefront of this development. While the smart city is not yet a reality in South Africa, most of the major urban centres (e.g., eThekwini, Tshwane, Johannesburg and Cape Town) have indicated interest in the potential thereof. Some have even undertaken a variety of initiatives to upgrade IT infrastructure and expand into e-governance services. Since such ideas are still evolving in South Africa, it is opportune to reflect on the potential, within this broader trajectory, to enhance the government-citizen interface.

SMART CITIES AND THE GOVERNMENT-CITIZEN INTERFACE

There is no agreement on a specific definition or criteria for a "smart city" (Sha & Son, 2015). Benton (2014: p. 6) for instance describes it in terms of "the so-called 'Internet of things' where everything from trains to streetlights is connected". Das and Emuse (2014: p. 932), on the other hand, believe the concept has to be understood holistically and inclusive of innovative transport and infrastructure networks, green and efficient energy systems, and smart governance. In a similar vein, Sha and Son (2015: p. 29) conclude that "the ultimate test of a city's 'smartness' is in how its technologies and organisational structures respond to the needs of its citizens". This coheres with Deloitte's (2014: p. 4) view that "the ultimate goal of a smart city is transformational". Thus it is seen as a form of governance that "uses digital technologies to enhance performance and well-being, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens" (SALGA, 2015: p. 5).

While there are many facets and varying technologies associated with smart cities, one notable trend expected to contribute to this transformational element is the use of ICTs as the primary communication channel between government and citizens. This is expected to alter the exchange of information between government and citizens through the mediation of big data and technology-driven processes. It includes, for example, the kind of mobile applications and "one-stop" portals through which residents can receive or provide information (Benton, 2014: p. 3). As discussed above, these kinds of tools are also fast emerging in South Africa, and may be indicative of the focus and scope of government communication strategy into the future.

What role can such communication technologies begin to play in South Africa's participation processes? According to Benton (2014: p. 1), such tools can broaden the reach of and access to information, as well as inspire more "active citizenship". For instance, ICTs can help those "with limited English proficiency, those who prefer to avoid interaction with city officials, and those who lack institutional knowledge about which agency to contact". Previously "hard-to-reach communities", it is argued, would also be more likely to participate in public engagements due to reduced costs of doing so (Benton, 2014). This would be especially relevant to those for whom access to the state is made difficult by call costs, fixed hours and insufficient resources (Van Belle & Cupido, 2013). Furthermore, specific "civic apps" can inspire and assist people to participate in online public forums, volunteer, give feedback on planning processes, or register to vote.

Many scholars interrogate this developmental path, however, in particular whether it will help to overcome or instead intensify the "digital divide" that characterises many countries, including South Africa. Some worry that this trend will reinforce a top-down approach to development and worsen existing inequalities and urban asymmetries (Watson, 2013).

1 In this article, we follow Mdlongwa's (2012: p.1) understanding of information communication technologies as "a global network in which ideas are exchanged, or information and knowledge is shared, through using communication like cell phones, and technology like computers, to connect people".

Data on the digital divide in South Africa for instance indicate that, while progress has been made to expand access to various technologies, much remains to be done.

FIGURE 1: PERCENTAGE OF HOUSEHOLDS WITH ACCESS TO TECHNOLOGICAL GOODS

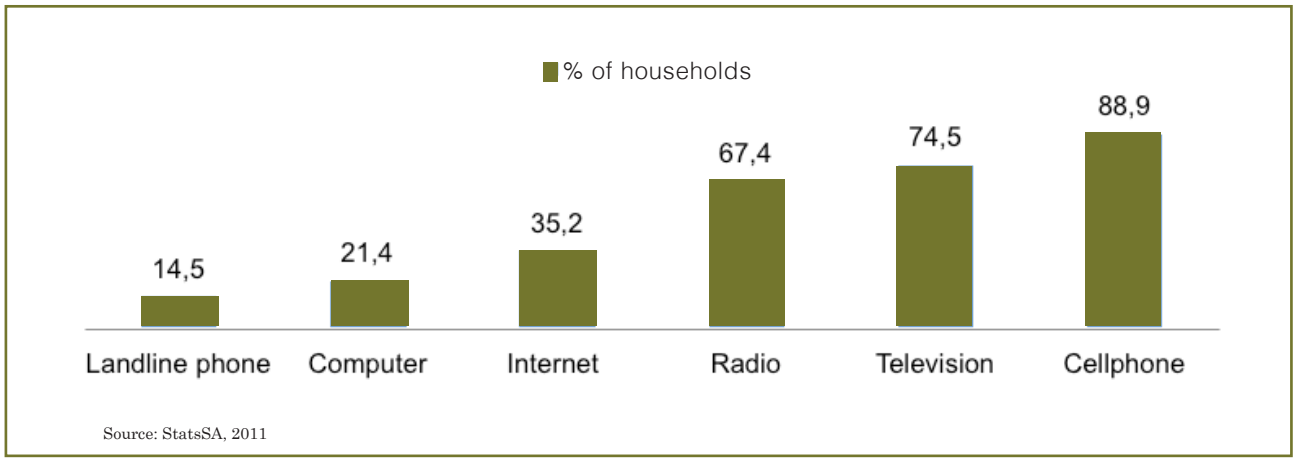


Figure 1 above illustrates the differential access households have to various resources. Despite limited access to computers and Internet, many scholars believe cell phones hold the potential to overcome common access hurdles (such as limited resources and mobility), and thus enhance "digital democracy" (Brown & Czerniewicz, 2010; Van der Merwe & Bohler-Muller, 2013). But addressing access to ICTs does not necessarily resolve other inequalities and backlogs, such as in basic services, education and skills development. While technology uptake offers empowering benefits, it is critical, as Odendaal (2006: p. 45) argues, that ICT strategies take into account the social difficulties and inequalities that they aim to solve and that already influences their uptake and impact. In other words, overcoming the digital divide means understanding that better technology does not by itself solve social problems and improve cities, nor can it simply transcend them (Hollands, 2008: p. 315). Importantly, it requires the participation of communities in order to result in actual, sustainable socio-economic change (Kariuki, 2010). There is a kind of circular relation, then, between the involvement of communities to ensure that technological innovations and applications address existing challenges on the one hand, and the use of technology to support and strengthen the involvement of communities on the other.

RESEARCH METHODS AND RESULTS

The qualitative and quantitative data used in this article emerged out of an HSRC research project aimed to support urban local governments to communicate and engage with communities. The qualitative component comprised 32 semi-structured, in-depth interviews with selected stakeholders across the country, including municipal officials (10), representatives from civil society organisations (17), and academics (5). Interviews were recorded and transcribed, and all respondents signed consent forms and were assured confidentiality. The interviews focused on: how engagement is understood and practised; how existing mechanisms operate; the relationships between municipalities and local communities; and any particular challenges to or opportunities for improvement.

The quantitative component of the study used the South African Social Attitudes Survey (SASAS), an annual survey of a nationally representative sample of adults aged 16 years and older, conducted by the HSRC. The survey aims to understand public perceptions on issues related to the country's social, political, and economic institutions. The 2013 leg of SASAS consisted of a representative sample of 2,885 respondents across all nine provinces. This article draws on a set of questions specifically designed and included as part of the HSRC research on engagement. It examined, among other things, citizen preferences for receiving information from local government, where options included television, radio, print media such as newspapers or municipal newsletters, face-to-face engagements, and ICT media such as computers, cell phones and the Internet. The grouping of some different platforms under a single category (e.g., computers and cell phones under ICTs) is one of the limitations of the survey. Also, there may be some communication tools that were not included. However, as a preliminary study of broader preferences, the data are indicative of general trends and sufficient to draw some conclusions.

QUALITATIVE RESULTS: KEY ISSUES IN COMMUNICATION AND ENGAGEMENT

The key issues that emerged from the interviews with stakeholders illuminate the complexity of, and existing challenges to, engagement. Some of these are particularly relevant for understanding the roles and potential of various communication platforms. These issues, summarised in Table 1 below, relate to three broad themes: communication and information dissemination; existing engagement mechanisms; and government and community relations.

TABLE 1: PERCEPTIONS OF KEY PUBLIC PARTICIPATION ISSUES IN SOUTH AFRICA

Communication and information dissemination	1. Limited and difficult access to relevant information
	2. Insufficient feedback loops
Existing engagement mechanisms	3. Diverse communities mean diverse needs and opportunities
	4. Lack of relevant knowledge and skills
	5. Insufficient allocation of resources
	6. Exclusionary structures and processes
Government and community relations	7. Perceived paternalistic attitudes
	8. Lack of trust and willingness to cooperate

COMMUNICATION AND INFORMATION DISSEMINATION

Most civil society respondents identified insufficient information exchange between municipalities and residents as a "key failing" (Vivier, Sanchez, Seabe & Wentzel, 2014: p. 15). Three notable issues emerged on this point: limited and differentiated access to information and to communication platforms; the incomplete or inaccessible nature of the information available; and the inadequacy of the types of platforms used. Citizens' lack of civic knowledge, including knowledge on how to engage government, was attributed to poor access to relevant information on government processes and functions. Thus many respondents criticised municipalities for failing to provide sufficiently comprehensive information, even where such information is formally requested or legally required to be available. This was seen as especially important insofar as citizens' ability to make meaningful inputs during engagement processes depends on the usefulness of information provided. One of the government respondents also believed poor communities in particular "do not have reliable forms of information compared to the middle class who have televisions" (Vivier et al., 2014.).

The types of platforms used by government to communicate and engage with communities were also perceived to be largely inadequate. Some identified specific platforms such as roadshows or large public meetings as inappropriate for discussing complex issues and decisions around development planning (Vivier et al., 2014: p.15). Other interviewees described communication between local municipalities and communities as haphazard and reactive, with information exchange reduced to "a one way conversation". Consultative meetings were perceived as ineffective due to poor timing in relation to actual planning processes. The result is often a limited chance for citizens to review necessary documents before meetings are held, and failure by the government to take citizen inputs into account (Vivier et al., 2014: pp. 13-14). Similar concerns were raised with regard to so-called feedback loops between citizen inputs and government decisions. Mechanisms for citizen inputs, from ward committee and IDP meetings to petitions and satisfaction surveys, lack adequate mechanisms to inform citizens of how their inputs have influenced decision-making. This is believed to hamper trust and interest in participation processes or government activities in general (Vivier et al., 2014: p. 15).

It is useful at this point to note the implications of these issues for government communication strategies, and the potential of using varied platforms and ICTs in particular. On the one hand, identified issues and barriers suggest that communication and information exchange platforms have a critical and constructive role to play in supporting more substantive forms of engagement. On the other hand, it suggests that, in order to have positive impact, government must pay attention to what information is and should be made available, and how it is presented. This also indicates the importance of linking information exchange to other engagement processes in order to "close the feedback loop".

EXISTING ENGAGEMENT MECHANISMS

Several issues that obstruct the effectiveness of existing participation mechanisms were also highlighted. Firstly, the diverse composition of communities makes it difficult for local governments to understand and meet the needs of all residents (Vivier, et al., 2014: p. 10). Socio-economic inequalities and differential access to infrastructure and services mean preferences and "burning issues" can vary drastically, as well as require different communication and engagement approaches. Currently, this reality is perceived to result in exclusionary participation and decision-making, in terms of not only access to information (as discussed above), but also the exercise of citizen voice. All respondents, including government officials, highlighted exclusionary tendencies within public meetings or ward committee and IDP meetings. Overly technical content and presentations, combined with tight time constraints, and even the use of English, can undermine the quality and inclusivity of engagement (Vivier et al., 2014: p. 10; see also Masiko-Kambala et al., 2012: p. 19).

While there was a general sense by all respondents that municipalities need to think more strategically around how to engage specific interest groups, the youth in particular were identified as a misunderstood and unengaged cohort (Vivier et al., 2014: p. 18). Furthermore, according to some respondents, more resourced or well-organised communities usually better understand how local government works and are thus better able to push their agendas (Vivier et al., 2014: p. 18). This may serve to exclude other groups, especially the poor. The issue of resources is thus integral to participation. An oft-cited challenge to effective engagement is insufficient resources and competencies to undertake intensive and lengthy processes, on the part of both citizens and municipalities. In this regard it is notable that it is usually under-resourced communities (i.e., the most poor and vulnerable) who need greater "voice" to ensure their needs are met, yet it is also they who tend to lack political power. Engaging such communities may also be more resource-intensive, as these are usually direct interactions that require provision of transport and catering.

Citizens' limited understanding of government operations or the implications of government proposals and decisions, as well as of their own rights and responsibilities, were identified as factors affecting capacities and willingness to engage (Vivier et al., 2014: p. 13). Knowledge gaps among local government actors were also identified, including knowledge of key government functions on the one hand, and the "softer skills" necessary to build relationships of trust and understanding on the other. Both CSOs and public officials acknowledged a lack of, yet significant need for, "social sensitivity" in how communities are engaged (Vivier et al., 2014: p. 13). Considering these expressed challenges with existing participation mechanisms, it becomes clear that, in order to improve information exchange and support meaningful engagement, strategic use of communication platforms should take into account issues of knowledge and resources, as well as existing patterns of exclusion.

GOVERNMENT AND COMMUNITY RELATIONS

There is a common perception among civil society representatives that local governments have paternalistic attitudes about their role in service delivery (Vivier et al., 2014: p. 10). Combined with a lack of trust between government officials and citizens, this has resulted in high levels of frustration that affect the willingness to cooperate. Accordingly, officials assume that communities (and especially informal settlement residents) do not always know what is best for them, and are not able to engage on important issues or contribute to development planning (Vivier et al., 2014; see also Fieuw, 2013: p. 67). From the perspective of the government respondents, however, where communities act in self-interested ways and fail to acknowledge or understand broader development challenges and implications, it becomes the state's responsibility to make decisions for the greater good (Vivier et al., 2014: p. 11).

These perceptions and experiences of government-community relations are an important indicator of levels of trust, which are necessary for effective engagement and building mutually beneficial relationships. High levels of frustration on the part of all stakeholders currently undermine participation processes and delay service delivery. Views from the different respondents reveal how stakeholders may experience the decisions and actions of the other in antagonistic and dismissive ways. According to some interviewees, frustrations emanate from broken promises and a failure to manage expectations, ultimately resulting in fraught relations and lack of trust and goodwill (Vivier et al., 2014: p. 12).

While issues related to information dissemination and existing participation mechanisms indicate great potential for improved communication and more strategic use of particular platforms, the context of government and community relations poses considerable challenges. Insofar as any form of communication is embedded in this context, government efforts and strategies to share, gather or discuss information must take into account low levels of trust and deep frustrations and citizen disillusionment with the state. In the next section we present key findings from the quantitative survey that indicate how citizens value different communication channels. Do these preferences reflect the challenges and frustrations expressed in the interviews? And what are the possibilities for new and emerging technologies to address these issues?

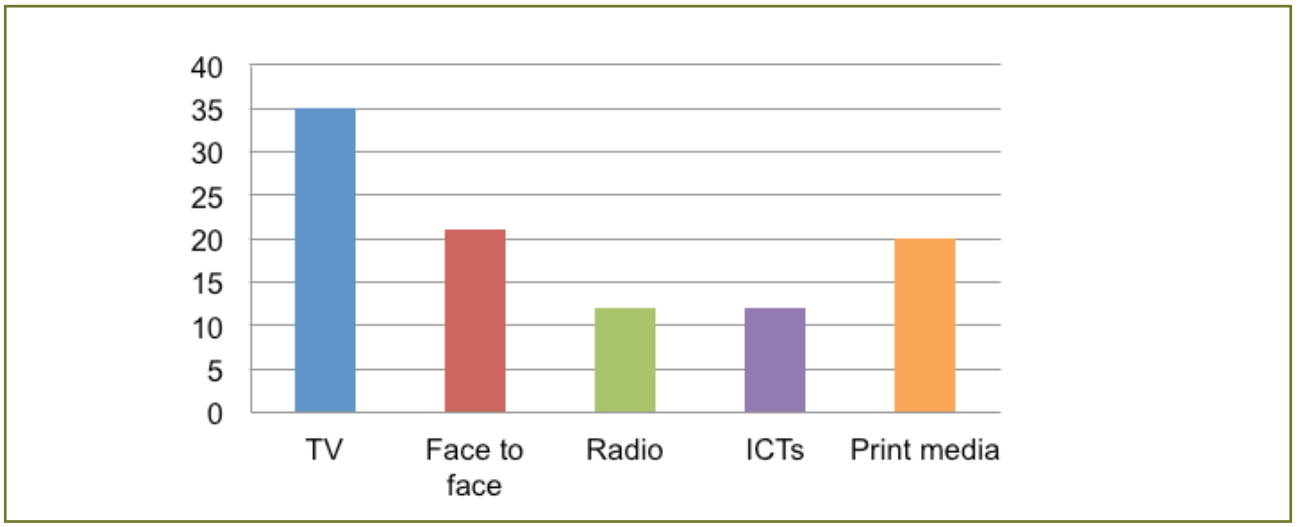
QUANTITATIVE RESULTS: CITIZENS' PREFERRED CHANNELS TO RECEIVE GOVERNMENT INFORMATION

Within this context, and in an effort to better understand information channels and flows between citizens and the state, descriptive analysis was applied to the 2013 SASAS findings. The aim of the analysis is to identify the most preferred channels to receive government information for different population groups. To broaden our understanding of the differences and nuances that do not fit the national pattern, factors that influence preferences were also examined.

While it is impossible to do justice to all variables that might influence preferences for particular media, Figure 3 below highlights some of these. In the context of government reach and citizen access to information, geographical areas and urban/rural differences are potentially important determinants. Race has, of course, also played a significant role historically in class formation (expressed here in terms of Living Standard Measure or LSM), and both race and LSM can be expected to have a bearing on preferences for certain technologies. Age is also a potential determinant, especially with respect to emerging new media. Gender has not been included given high similarity of results.

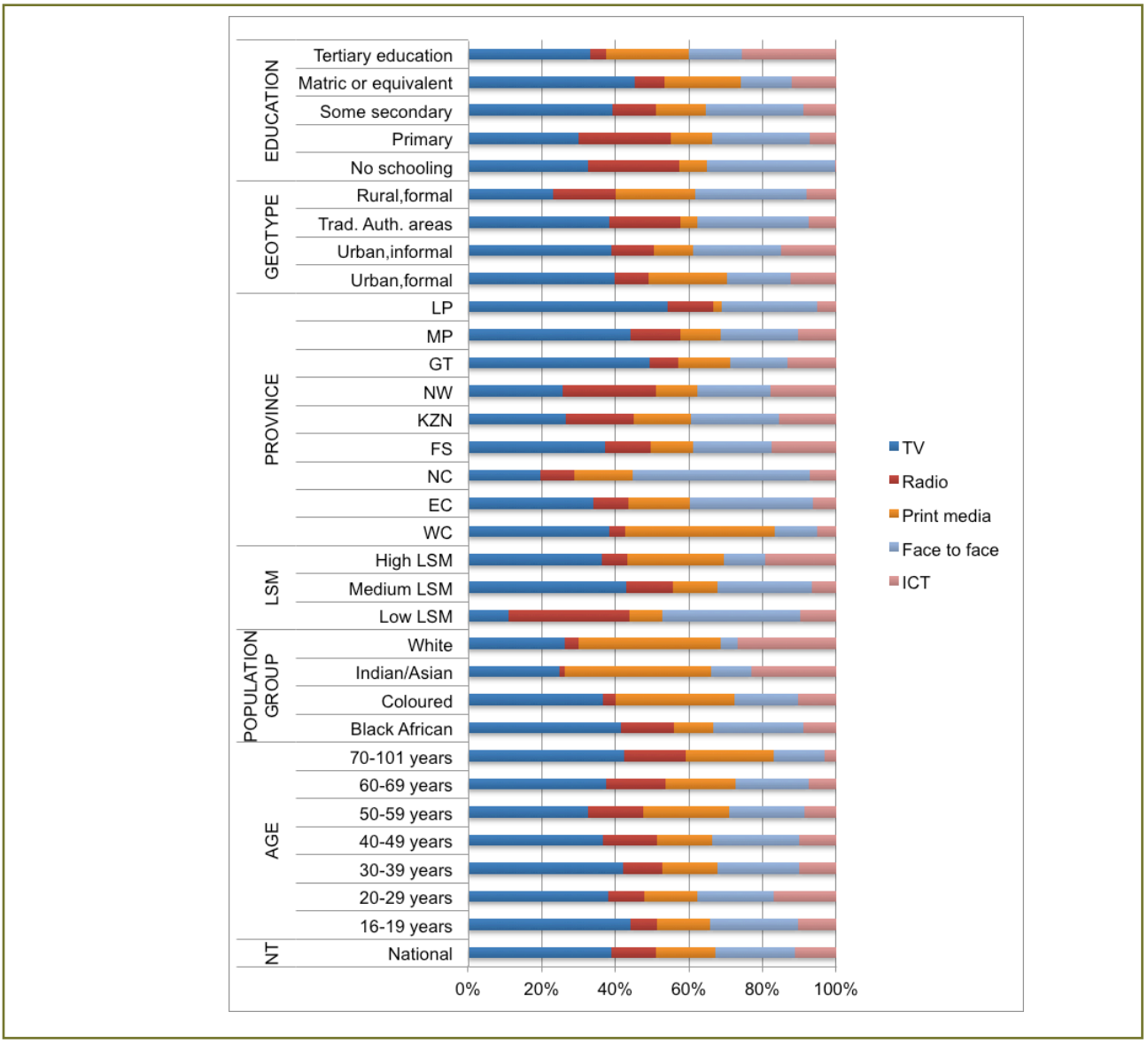
The findings from the survey indicate national interest in particular platforms to receive information from government (see Figure 2).

FIGURE 2: MOST PREFERRED MEDIUM TO RECEIVE INFORMATION (NATIONAL AVERAGE)



As shown, television stands out as the most popular choice to receive information from government, while low levels of interest in ICTs largely confirm the current digital divide. Noteworthy is the relatively high interest in face-to-face engagement, especially given the vast challenges that plague such processes. A closer disaggregated examination of the data (Figure 3) reveals that preferences for particular communication channels are not uniform for all subsections of the sample.

FIGURE 3: MOST PREFERRED MEDIUM TO RECEIVE INFORMATION, ACCORDING TO SELECT VARIABLES



Examining the disaggregated data in Figure 3, some interesting nuances become apparent. For instance, differences in television, radio and print media may reflect varied education and literacy levels, or obstacles such as distance that affect physical access. The relatively high interest in television and print media in rural areas may, however, discount this latter possibility. It is also noteworthy that 16 to 19-year-olds reported a high level of interest in direct engagement with government, higher than all the other age groups. This should be considered in terms of how government can and/or should engage youth voices and the needs and interests of younger citizens.

Finally, information communication technologies (ICTs) were rated the lowest of all the choices and were not chosen as the primary channel by any demographic category. While ICTs were most popular among 20 to 29-year-olds (16%), this figure was still outweighed by interest in television and face-to-face as the preferred media for information within this group. These findings align with those of an earlier 2003 survey, which also found that "access to digital technologies is informed by similar socio-economic, demographic and geographic cleavages to those characteristic of many other, older information and communication media and technologies" (e.g., radio and television) (Langa, Conradie & Roberts, 2006: p. 142). The authors also identified in particular income and social status, urban-rural differences, race and age, as well as basic literacy and education, as factors that influence exposure to and usage of computers and Internet (Langa, Conradie & Roberts, 2006: p. 134).

It would be worthwhile to further explore public attitudes and use of these different typologies. ICTs alone could be unpacked into a much broader range of tools and forms of access (e.g., own computer versus shared or publicly/privately provided computer; cell phone versus smart phone; which platforms on the Internet are most preferred; etc.). For the purpose of this article, we are interested in the implications of the quantitative and qualitative results for understanding the potential of various communication platforms. In the next section we explore these preferences in relation to the reported barriers to meaningful engagement.

DISCUSSION

In this section we approach the two key research questions in the context of the three thematic areas identified from the qualitative findings. Thus, assessing the most suitable platforms to improve government-citizen communication can be situated within the discussion of issues related to communication and information exchange. Determining whether and how ICTs and other platforms could promote substantive engagement involves understanding challenges with existing engagement mechanisms, as well as government and community relations.

MOST SUITABLE PLATFORMS FOR IMPROVING COMMUNICATION: TAKING A DIFFERENTIATED APPROACH

There is high potential for various mass media and ICTs to better address issues around access to information and feedback loops. First, the findings from the quantitative and qualitative research suggest the need for government to make use of a broad range of platforms. Such a differentiated approach should address, at least to some extent, access and exclusion barriers. While the quantitative data do not allow us to distinguish between access to and mere lack of interest in particular media, it is reasonable to believe these are closely linked. Strategies to communicate with residents should therefore take into account both access to particular channels and infrastructure (as shown in the census data), but also expressed preferences. Furthermore, low interest in specific media could indicate a need for greater education and awareness-raising around those platforms, as well as improving the value of and citizen trust therein.

Taking a differentiated approach would also mean taking into account both what the most appropriate media are for a particular area and cohort, and acknowledging what groups may be excluded. For example, given the generally limited reach of print media and ICTs, government's communication strategies could take cognisance of which cohorts would most likely not use these channels and what approaches would be appropriate to reach them. Specific efforts to engage the most poor and marginalised, for instance, could make better use of radio (even more so than television), but not at the cost of direct interactions. Province-specific strategies may, for instance, call for a greater emphasis on print media in the Western Cape, as this was the most preferred channel. Or it may signal a need to enhance the use of radio and face-to-face engagements to reach other cohorts who may currently be excluded.

The suitability of the various platforms must also be assessed according to the quality, relevance and accessibility of the content. For instance, given the popularity of television across all cohorts, strategic reflection on the use of this technology to provide relevant and useful information to residents across the country is necessary. Key questions to ask may include: what content is currently being provided? Is the content relevant for enhancing understanding and interest in government functions and engagement opportunities? Is the content accessible in terms of language, clarity, simplicity, etc.? And are there opportunities for deeper civic education around key government processes and citizen rights and responsibilities through television? By being cognisant of these kinds of matters, government can become more pro-active in the provision of relevant information.

It is also at this level that ICT platforms (and strategies reflecting smart city thinking) could be harnessed to fill significant gaps. The low levels of interest in ICTs, alongside the increased access to mobile phones and the Internet, may be indicative of a still slow emergence of relevant websites and apps, rather than some kind of opposition. The growing use of a wide range of applications and websites may thus gain more traction as these become more relevant and available. And as the qualitative research has shown, one avenue is for such tools to help link the timing and content of communication to other service delivery and engagement processes. A kind of "before and after" approach could close important feedback loops, which could serve to acknowledge and thus motivate citizen inputs in government processes, as well as strengthen government accountability to actually respond to such inputs.

PROMOTING SUBSTANTIVE ENGAGEMENT THROUGH ICTs

While the qualitative data emphasise challenges and severe limits to existing participation mechanisms, the quantitative results show the importance of strengthening these approaches. It is indicative that, across LSMs, geographic spaces, and even levels of schooling, people desired direct interaction with government representatives. It should be encouraging that citizens value democratic processes that build personal relationships with their local governments. Any communication strategy or process should therefore support and strengthen direct engagements rather than being seen as an end in itself.

A key role for ICTs in supporting substantive engagement is to address patterns of exclusion, as well as reduce costs and facilitate knowledge and skills sharing. These were noted as key limitations on the part of both citizen and state actors. By enabling more direct access to the state for individuals, such platforms may counter the dominance of particular community interest groups and contestations. At least with regard to basic infrastructure services, for example, ICTs and other such platforms allow a person to report and access information individually and directly, with the same reporting system and procedures applied to all residents regardless of geographic location. Such platforms could also help to overcome exclusionary tendencies within engagement processes if they provide materials under discussion in different or simplified language, for instance. Finally, such tools can provide channels for greater knowledge and skills sharing, which may support and improve the quality and effectiveness of more resource-intensive activities (like public meetings) by ensuring participants receive and understand important information beforehand. Importantly, interactive platforms may turn individual access to information into a social process of mutual sharing and learning. Many scholars believe ICTs can, in this way, enable broader and more effective social networks and thus strengthen social capital (Mandarano, Meenar & Steins, 2010: pp. 131-132).

Despite this positive potential of using ICTs and other communication platforms, the fact that socio-economic disparities across South Africa continue to influence access to, as well as experience and knowledge of such technologies, must be heeded. These divisions are reflected in the expressed levels of interest in these platforms, which the SASAS data have shown remain notably low. For those with little or no education, from the low LSM or less urban areas, access to these communication technologies may be the critical factor. But addressing ICT access does not necessarily guarantee uptake and effective impact. In fact, the concept of the "digital divide" itself has attracted criticism for a predominant emphasis on socio-economic factors impacting on people's access to ICTs, at the exclusion of socio-personal factors such as low levels of awareness, interest, understanding and acceptance thereof (Macintosh, 2004: pp. 60-61). Thus, mobile apps that allow one to report on water shortages or vandalism of communal toilets, for instance, will only be as effective as the "reporting agency" of users combined with the capacity and responsiveness of service providers. In this regard, the value of substantive engagement and the nature of the relationship between government and citizens become all the more apparent and relevant.

GOVERNMENT AND COMMUNITY RELATIONS: LIMITS TO ICT POTENTIAL

So far, we've discussed how standard forms of communication and participation could support if not generate more fruitful and sustained forms of engagement. This could open further opportunities for residents to support municipal functions, and thereby improve local relations and efficiency. However, rolling out ICTs as the preferred mode of the government-citizen interface in areas where the presence of the state is weak and the relationship between residents and government problematic (or confrontational as it is in many cities) could have a negative impact.

It is therefore important to be aware of perceptions of, and tendencies towards, a paternalistic approach by government, and the ways this might manifest in government communication preferences with citizens. A possible limitation of most communication platforms in the context of contemporary urban South Africa is that they primarily work as one-way channels. When information is transferred either from government to citizens or from citizens to government, a platform for conversation is not realised. This kind of exchange can only go so far in addressing citizens' frustrations around service delivery and overall relations with government. Many scholars therefore warn against the replacement of direct engagements with virtual relations, arguing that "the unique characteristics of face-to-face communications in building consensus, communicating complex information, or creating new ideas mean it cannot be totally replaced by online communications" (Goodspeed, 2008: p. 33). The kind of "governing at a distance" (Odendaal, 2003: p. 588) that emerges through the greater use of ICTs may provide an efficient form of communication and information provision, but it does not necessarily provide a meaningful form of interaction with citizens to build relationships of trust and good will.

The demand for direct engagement from the South African public also seems to cohere with scholarly arguments for conceptualising approaches to the smart city in a way that puts citizens and communities, as well as existing civic knowledge and engagement processes, at the centre of development. Odendaal (2006: p. 45), looking specifically at the South African context, observes how many of the benefits of ICTs (for example as a means of learning and networking) will fail to materialise if ICT uptake in governance is driven only by the desire to promote economic growth and bureaucratic efficiency. Ochara (2012) makes a similar point with regard to citizen participation in e-governance projects. He goes further to argue against current approaches that characterise citizens as consumers and "the relationship between government and citizens as a passive commercial transaction" (Ochara, 2012: p. 40). What is thus needed is to embrace the potential of information technologies in combination with two-way communication channels and more substantive direct interactions.

CONCLUSION

This research investigated South African public preferences for different government communication platforms, in light of reflections from a variety of stakeholders on the challenges to existing participation practices. Understanding such preferences could assist government to strengthen its communication strategies and broaden the reach and impact of its communication tools. This research has shown that a differentiated approach, utilising the full range of media options, is important for reaching such a diverse populace, and for addressing issues and patterns of exclusion. Understanding the nuances of such differences enables more targeted campaigns tailored to the specific needs, interests and capacities of particular cohorts (e.g., youth, urban or rural dwellers).

It is ultimately not merely access to, but the use and value of communication tools that translate into meaningful engagement. Thus the state should reflect upon, and improve the quality of, relevance and accessibility of the content of information, as well as remain cognisant of new forms of exclusion that might emerge. In this regard, research into citizens' information needs vis-à-vis the current content of government-provided information may enhance the relevance of particular efforts. Specific socio-economic factors such as education may also impact on citizens' perceptions of the reliability and value of particular platforms. Effective communication and information exchange therefore hinges on the nature and quality of governance as a whole (e.g., education and skills training, basic service delivery, local economic development, perceived reliability and trustworthiness).

With regard to strengthening engagement, ICTs and other communication platforms hold great potential to address the concerns raised around existing participation mechanisms. Perhaps a first step is to include ICT tools to improve efficiency within existing communication platforms or as part of new engagement methodologies. More research, thinking, and efforts are needed to ensure that language, social and geographical barriers are properly acknowledged in order to make ICT-based platforms more inclusive and accessible. However, issues related to government and community relations warn of the limits of one-way communication channels, and the need for earnest relationship building that information-exchange processes may not be able to provide. It is significant that all population groups preferred direct engagement over ICT-mediated communication. Rather than signal an out-dated attitude and approach, this should be embraced as an opportunity for meaningful engagement between a responsive government and an informed citizenry to pave a way for technological advances that serve rather than define democratic processes and urban development.

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INTERNET VISIBILITY AND CYBERBULLYING: A SURVEY OF CAPE TOWN HIGH SCHOOL STUDENTS

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ABSTRACT

The pervasive and open nature of the Internet in the everyday lives of South African children has facilitated benefits such as increased collaboration, learning opportunities and access to knowledge (A2K). However, the online environment's increased visibility has at the same time provided new ways for children to bully each other, and the evidence in the available literature suggests that online bullying – "cyberbullying" – may result in more harmful consequences than offline variants of such behaviour.

This article provides findings from an online survey of cyberbullying experiences among a sample of high school students aged 15 to 21 years in the city of Cape Town. The survey found clear evidence of cyberbullying, as reported by both victims and perpetrators, and it was found that social networking sites (SNSs) were the online spaces most-used for cyberbullying, followed by short message service (SMS) platforms. Among perpetrators, 19% reported that they cyberbullied once or twice a week and 10% said they cyberbullied every day or almost every day. The survey also uncovered gender differences in the length of time it took for victims of cyberbullying to put the incidents behind them, with more females than males taking a long time (i.e., a few weeks, or a month or two or more) to stop feeling "bothered" by the incident.

The authors conclude that the findings show a need for improved efforts, in schools and in student households, towards building learners', parents' and teachers' e-safety awareness and capacity for preventative action.

KEYWORDS

cyberbullying, online risks, children, South Africa

INTRODUCTION: CHILDREN AND THE ONLINE ENVIRONMENT

The speed with which children are gaining access to information and communication technology (ICT)-enabled social media, media, Internet content and mobile platforms is unparalleled in the history of technological advancements (Livingstone et al., 2013). The progress and use of digital media have escalated quickly, and improvements in social networking sites (SNSs), mobile media devices, and networked games are finding favour with children (Shipton, 2011). The level of adoption of mobile phones amongst children has increased significantly in the last decade, and along with this there has been an increase in the capabilities of mobile handsets (Lenhart, 2009). Children use their handsets for communications through voice calling, text messages, accessing the Internet, and taking and sharing photographs and videos.

Accordingly, Internet activities amongst children have increased exponentially across the globe in the 21st century (Tokunaga, 2010) and have become embedded in their lives (Livingstone et al., 2013).This is also true of children in South Africa (De Lange & Von Solms, 2011; Oosterwyk & Parker, 2010). The wide variety of platforms for accessing the Internet, and unrestricted access to social networking sites and chat rooms, have been pivotal in the way children's communications have evolved in the 21st century (Badenhorst, 2011; Du Preez 2012). Children are proficient with, and regularly use, technology (Mishna et al., 2010).They are highly dependent on this technology for interaction and connection with others, as well as for activities such as homework and games. The increasing significance of these activities has motivated many conversations about the benefits and risks of this constantly changing technology. The benefits of the Internet relate to the many opportunities available for entertainment and for activities facilitated by enhanced access to knowledge (A2K),[1] such as learning and developing skills of collaboration and creativity (Helsper & Eynon, 2010; Zhong, 2011).

With all the benefits and opportunities made available by the Internet, there are accompanying risks that cannot be ignored (Staksrud & Livingstone, 2009). Associated with the increase in adoption of Internet use by children, fears about children's online risk to harm have become a prominent feature in research and public discussions (De Lange & Von Solms, 2011; Staksrud & Livingstone, 2009).

Because the nature of the Internet is self-regulatory and open or "visible" to everyone (Kopecky et al., 2012; Lorenz et al., 2012), children are offered many diverse opportunities to publish material (Jackson et al., 2007). This openness or "visibility" allows all material and content to be available to anyone with access, and therefore understanding and highlighting risks is often complex (Cranmer et al., 2009). For instance, content that is deemed inappropriate for younger children of six to eight years of age could possibly be appropriate content for adolescent children aged 16 or 17 (Boyd et al., 2009).

1 See AJIC Issue 16, 2015, for more on A2K matters.

Some studies have found that children are often unaware of the dangers of the Internet, which can lead to unsafe behaviour, such as posting personal information on public sites and cyberbullying (De Lange & Von Solms, 2011). However, in other studies (see Livingstone et al., 2013), children have been found to be highly aware of risks, with a long list of concerns related to their online usage.

There can be little doubt that children need to be made aware of the risks from an early age, and be provided with guidance, in order to keep them safe whilst online. However, parents are frequently ill-equipped to deal with the threats, due to lack of experience and education regarding the Internet, and often unaware of the activities that children are involved in. There is often a vast divide between children and their parents with regard to cyber knowledge and activities.

Among the online risks affecting adolescents, cyberbullying has been found to be the one that causes the most harm (Haddon & Livingstone, 2012). Cyberbullying can be defined as intentional and persistent harm to a person caused by a group or person via the use of electronic media (Hinduja & Patchin, 2013). Peer victimisation and bullying have always been an issue for schools and parents alike (Patchin & Hinduja, 2010), but the Internet has the potential to increase the extent and impact of bullying due to the possible anonymity of its perpetrators and the possible wide visibility of the bullying behaviour (Boyd et al., 2009).

Children involved in bullying or victimisation by bullies have reported higher levels of depression across all four forms of bullying: physical, verbal, relational and cyber (Wang et al., 2011). This depression has resulted in an examination of cyberbullying as a phenomenon in several unfortunate cases of teen suicide (Dooley et al., 2009; Patchin & Hinduja, 2010).

Evidence of instances of cyberbullying among school children is of great concern, because schools should be places where young people develop confidence and a strong sense of self-worth. While several studies have investigated the extent of cyberbullying, West (2015) argues that additional research studies related to the details and consequences of cyberbullying are required particularly in the 16 to 19 year age group. However, the West (2015) study investigated cyberbullying in a post-compulsory education context in England, and the findings concluded that while cyberbullying is present in this context it is lower than in a school context. Hinduja and Patchin (2013) investigated cyberbullying among middle and high school students in the US. While evidence confirmed that cyberbullying was prevalent in these schools, occurrences were relatively low. However the study only investigated cyberbullying that had occurred in the previous 30 days (Hinduja & Patchin, 2013).

The purpose of this research was to determine the extent of cyberbullying experienced among students in Grades 10 to 12 (typically in the 15- to 21-year age group) at a set of high schools in South Africa's second-largest city, Cape Town; to determine the potential impact of these experiences; and to examine any possible gender differences in the bullying or in the responses to the bullying.

The next section of this article outlines the research survey that was conducted. This is followed by a section that provides conceptual framing for the research via a review of existing literature on children's exposure to online risks, including cyberbullying. Then there is a section investigating the South African literature. The research findings are then provided, followed by a final section of conclusions and recommendations.

In this study, the term "children" is used to refer to girls and boys of school-going age, i.e., aged 6 to 18 years, but with the upper age limit going higher than 18 yeards in cases (as in the sample we surveyed in Cape Town) where a student may need to stay in high school beyond the age of 18 years). Many of the dynamics of cyberbullying are particularly pronounced in the teenage years, and that is why our research focused on high school students.

THE RESEARCH

The population that this study looked at was learners in Grades 10 to 12 in selected classes at selected secondary schools in a Cape Town education district. Grades 10 to 12 in South Africa are the final three years of high school, meaning the students are typically aged between 15 years and 18 years, i.e., in their final years of childhood, with a few students older than that (primarily due to repeating of failed years).

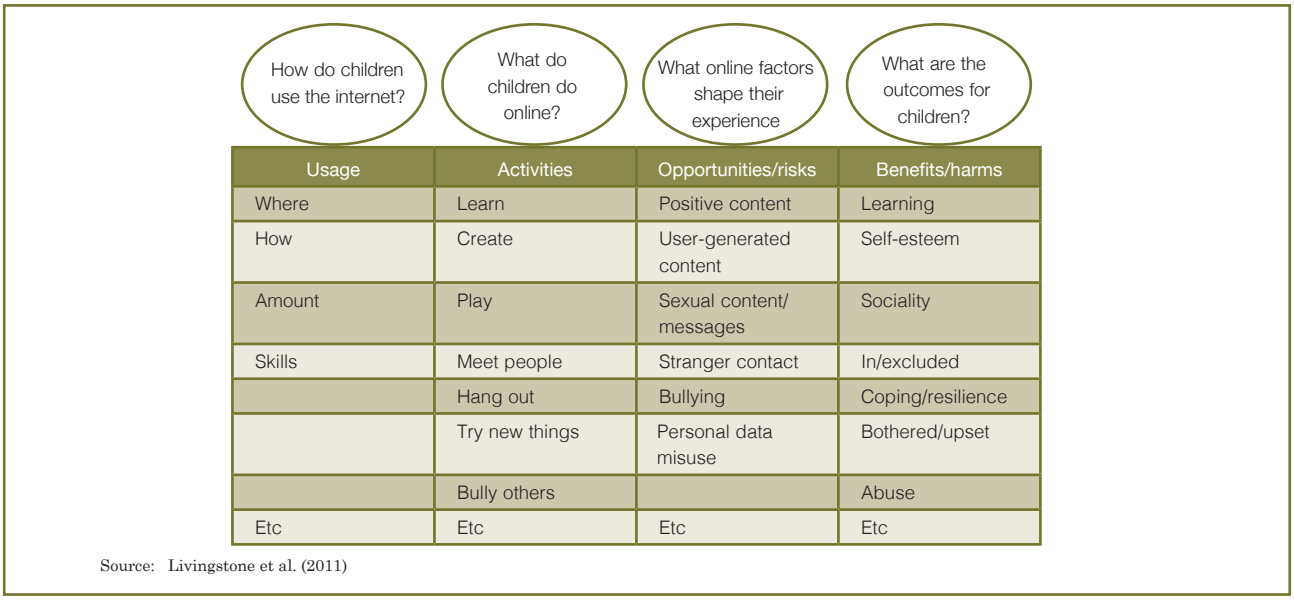
A non-probability convenience sampling technique, based on the purposive sampling method (Saunders et al., 2009), was applied. As the study was exploratory, as well as needing to adhere to time constraints, this method was the most appropriate. Nine schools were selected to participate in the study, with the schools chosen on the basis of the types of activities observed on the ChatSA website (http://www.chatsa.biz/). At each school, one class in each grade (Grades 10, 11 and 12) was requested, via the school's principal, to take part in the study.

The learners' home languages were primarily English, Afrikaans or Xhosa, which are the three South African official languages most widely spoken in Cape Town. A total of 324 students, aged between 15 and 21 years, were targeted, and 310 responded to the survey.

We used a post-positivist approach – an approach that allows individuals' instincts, philosophies, morals, beliefs, education and social standing to be taken into account in understanding what influences their perceptions and realities (Guba, 1990). It was felt that use of this post-positivist lens to frame the research would allow children's actions and reactions in the online world to be grasped.

The research adopted a deductive approach to the theory since it used an existing conceptual model: a model published in 2011 by the EU Kids Online research project (Livingstone et al., 2011). The model, outlined in Figure 1 below, traces the possible consequences of children's online activity according to four sets of elements: (1) how children use the Internet, (2) what they do online, (3) the online factors shaping their experience, and (4) the outcomes for the children.

FIGURE 1: MODEL FOR RESEARCHING CHILDREN'S ONLINE ACTIVITIES



Usage	Activities	Opportunities/risks	Benefits/harms
Where	Learn	Positive content	Learning
How	Create	User-generated content	Self-esteem
Amount	Play	Sexual content/ messages	Sociality
Skills	Meet people	Stranger contact	In/excluded
	Hang out	Bullying	Coping/resilience
	Try new things	Personal data misuse	Bothered/upset
	Bully others		Abuse
Etc	Etc	Etc	Etc

Source: Livingstone et al. (2011)

Data were collected and analysed via an online survey based on a survey instrument developed by EU Kids Online that had already been tested and used in 25 countries across Europe to gain insight into the risks and experiences that children encounter online. (Hasebrink et al., 2008). Using this online survey tool allowed the number of respondents to be maximised while minimising the time and labour required to gather the data (Saunders et al., 2009).

The research questions we sought to explore via the survey were as follows:

1. To what extent do high school learners in Cape Town encounter cyberbullying?
2. To what extent are the learners who experience cyberbullying bothered by it?
3. To what extent are there gender differences in the perpetrating or experiencing of cyberbullying?

The study complied with the ethics and confidentiality guidelines of the University of Cape Town (where two of the authors of this article are based). There were some potential limitations to this study. One was that the high schools were not chosen randomly; they were chosen specifically because they were using the aforementioned ChatSA website. Another potential limitation was the relatively small sample size (310 respondents). In addition, the respondents' parents and teachers were not questioned or interviewed.

ONLINE RISKS FOR CHILDREN

Children are often portrayed as techno-savvy users of the various technologies (Mishna et al., 2010). A study by Helsper and Eynon (2010) confirmed that young people use the Internet more than their older counterparts. Children tend to use the Internet as their first port of call, have higher levels of Internet self-efficacy than older people, and use the Internet for fact-checking and formal learning activities. But at the same time, in examinations of online risk, children are often portrayed as innocent, vulnerable and in need of protection (Vickery, 2012), and parents are urged to take on the important role of supporting their children's use of technology and providing guidance (Helsper & Eynon, 2010).

Staksrud and Livingstone (2009) maintain that children are active agents in their own lives, and that they use the Internet to express themselves, to socialise, and to discuss their frustrations. Among other things, children use the Internet to post pictures, fall in love, end relationships, and avenge each other (Livingstone & Haddon, 2009). Children are playful by nature and often use the online environment to experiment with new behaviours, as their offline lives tend to be restricted by parents, teachers and schools. These behaviours can expose children to several opportunities and risks. Such exposure has initiated expectations and dismay from policy communities, the public and private sectors, and parents alike (Livingstone & Helsper, 2010).

While pornography has for more than two decades been seen as the highest of the online risks (Livingstone et al., 2013), additional potential high-risk exposures have emerged, such as exposure to "sexting" (the sending of sexually explicit messages or pictures electronically), self-harm, personal data misuse, interactions with strangers, and the

subject of this article: cyberbullying (Kopecky et al., 2012; Livingstone et al., 2013; Sharples et al., 2009; Staksrud & Livingstone, 2009). Boyd, Marwick, Aftab and Koeltl (2009) point out that the risks children take and face online tend to equal the risks they take and face in the offline world, and that technology merely moves longstanding fears and risks to a digital platform. Livingstone and Haddon (2009) also argue that the medium (the Internet) is not the root cause of the risks that adolescents experience; rather, the message is the key problem. Regardless, online harassment or bullying is typically more visible, to more people, than offline bullying.

The increased visibility of the Internet has provided new ways for adolescents to torment each other, and it has been persuasively argued that online bullying is often more harmful than the offline version, because the Internet amplifies messages and intensifies cruelty by making it more widely visible (Kopecky et al., 2012). (At the same time, however, this increased visibility can potentially make it easier for adults to see the online bullying than to see its offline variants.)

A classification framework created by the aforementioned EU Kids Online project (Hasebrink et al., 2008), classified the various factors influencing online benefits and risks experienced by children. The age, gender and socio-economic status (SES) of participants were used as the main independent variables in examining the variances in benefits and risks. In a 2013 EU Kids Online survey of 10,000 children in Europe (Livingstone et al., 2013), it was found that the primary risks adolescents faced online were pornography, cyberbullying, exposure to sexual content, sexting and personal data misuse (Livingstone et al., 2013). The top three most risky platforms were considered to be, in descending order of risk, video-sharing sites, websites and social networking sites (SNSs). *Content*-related risks were the highest risks mentioned by children, with 58% identifying pornographic, violent or other content risks first. *Contact*- or *conduct*-related risks such as bullying, along with other risks such as viruses, were mentioned by nearly half (42%) of the children in the study as the highest risk. This was the opposite ordering to what parents expect, since they would put contact-related risks at the top of their concerns. The reason that conduct-related risks came second in the children's ranking of concerns is most likely due to the fact that cyberbullying and sexting is linked to the widespread use of mobile, personal and networked devices.

An earlier EU Kids Online study (Livingstone et al., 2011) found that a lower percentage of children reported being exposed to cyberbullying as compared to exposure to other risks (such as sexting or meeting strangers offline), but the children reported that cyberbullying had a more harmful impact on them than exposure to other risks. It must be borne in mind that what adults consider risks (i.e., meeting strangers) can be seen by adolescents and children as opportunities (Livingstone & Haddon, 2009).

Meanwhile, an American study by Lenhart, Purcell, Smith and Zickuhr (2010) found that 26% of US teens and young adults reported being tormented or harassed on their mobile phones, while the percentage reporting that they had received a "sext" text message was much lower at 15%, and only 4% reported having sent a sext.

As shown in the EU Kids Online model (Livingstone et al., 2011) in Figure 1 (in the section of this article entitled "The research"), potential harms that can result from Internet activity include feeling excluded, feeling upset or bothered, and, in more extreme cases, suffering abuse. While confirming the argument that there are risks to children using the Internet and other online platforms, Livingstone et al. (2011) at the same time propose that the margin for harm resulting from the risks is often surprisingly small.

Regardless of their scale, harms experienced online by children cannot be ignored. Adults have attempted to place restrictions and regulations on children to limit online activities, but these have not proved adequate (Staksrud & Livingstone, 2009). Placing increased restrictions on online activity may not be the answer. There is evidence to suggest that the perception that parents and teachers are placing restrictions on their online activity may make children reluctant to request help from parents and teachers if and when they experience a problem online – as such a request would force the child to reveal an element of her / his online activity (Staksrud & Livingstone, 2009). Adolescents fear that punishment, and more restrictions, will result from requests for help. More often than not, they will confide in a friend, rather than a parent or teacher, when confronted with an online issue that bothers them (Hasebrink et al., 2008). Increased e-safety education in schools could increase the trust relationship between learners and teachers with regard to online activities (De Lange & Von Solms, 2011).

Cyberbullying incidents can be classified as *direct* or *indirect* (Bauman et al., 2013). With direct cyberbullying, the bully makes contact with the victim directly, for example by sending him/her a malicious text message. In indirect cyberbullying, the person responsible may not be known. An example of indirect cyberbullying is gaining access to another person's email account or social networking page and either falsely claiming to be that person (and sending out messages or making postings in that person's name); or blocking access to the account so that the person cannot use it.

Cyberbullying behaviour includes the distribution of humiliating pictures or videos about a particular person, making unkind remarks about someone, or cyber-stalking someone online (Mishna et al., 2009). Cyberbullying characteristically involves repetition, as the media (pictures or text) distributed online can be repeatedly re-distributed, and viewed and re-viewed, with no geographical limitations. Specifically on mobile phones, cyberbullying can take the form of sending malicious text messages, sexting, or taking pictures or videos of someone with the intention of distributing the content to others via a mobile network or the Internet (Hinduja & Patchin, 2013).

The characteristics of the behaviour in cyberbullying are to a great extent the same as in its offline counterpart, but with the culprit or culprits able to be anonymous and the offending behaviour visible to many more people (Cowie & Colliety, 2010). Perceived anonymity plays a major role in the ability to harass others online; being able to hide one's identity enables adolescents to act in ways that they would not normally act if their identities were known (Mishna et al., 2009). Individuals can impersonate others online, or set up fake profiles, in order to perpetrate cyberbullying. However, in spite of this perceived anonymity, Boyd et al. (2009) found that cyber victims typically have the ability to figure out who the culprit or culprits are and generally do figure it out. And, in a high percentage of cases the culprit is known to the victim.

In the US, some studies have found that male children are more likely to be cyberbullies (Hinduja & Patchin, 2013; Wang et al, 2009), and that females are more likely to be cyber victims (Wang et al., 2009). But other studies in Sweden (Slonje & Smith, 2008) and in the US (Williams & Guerra, 2007) have found little or no gender difference in cyberbullying or being cyberbullied.

A Canadian study (Mishna et al., 2010) of middle and high school students reported that nearly half (49.5%) of the respondents had been bullied online in the previous three months. And the Hinduja and Patchin (2013) study of middle and high schools in the US found that 5% of participants had cyberbullied others more than once.

Just as reported incidences of cyberbullying vary, so too do reports of the degree of upset that cyberbullying causes. One US study found that children preferred to use the term "drama" rather than cyberbullying, and in this way to allow themselves to be classed less as victims or culprits in the bullying incidents (Marwick & Boyd, 2011). For instance, in this study, a female respondent labelled her victimisation as "drama" even while acknowledging that incidents were affecting her emotionally. The "drama" label seemingly made the actions more acceptable to her, and she sought to brush the perpetrator's actions off as attention-seeking (Marwick & Boyd, 2011).

Because self-esteem plays a significant role in children's development, particularly in their teenage years, the positive or negative outcomes of online interactions are an important facet of their experience that needs to be thoroughly investigated (Patchin & Hinduja, 2010). Teens tend to look for settings where they will be socially accepted, and to avoid places where they could be marginalised or isolated. The negative effects of cyberbullying on teens (both the recipients and the perpetrators) need to be clearly documented (Hinduja & Patchin, 2013).

An EU Kids Online study (Ólafsson et al., 2013) reported that while certain risks (such as seeing intimate pictures or being propositioned online) were encountered by one in eight children (12.5%), not all children were necessarily bothered by the encounter. What did bother the children the most was receiving hurtful messages.

THE SOUTH AFRICAN CONTEXT

The South African population, according to study commissioned by the United Nations Children's Fund (UNICEF), is one of the main consumers of mobile technology and social networking on the African continent (Beger & Sinha, 2012). Statistics from Effective Measure, the web traffic measurement vendor for the country's websites, has revealed that nearly 49% of South African Internet users are male, compared to just over 51% of users that are female (Slonje & Smith, 2008).

A 2011 study of primary and high school learners in the Nelson Mandela Bay Municipality of South Africa's Eastern Cape Province found that 90% of respondents used SNSs (De Lange & Von Solms, 2011), and that 67% were accessing these sites on a daily basis. Two SNSs, Mxit (a South African mobile social network) and Facebook, were found to be the most popular sites amongst the surveyed youth, and social networking was their favourite online pastime, followed by gaming (De Lange & Von Solms, 2011). This same survey found that 36% of the surveyed learners had experienced cyberbullying to some extent. A survey of 303 learners from Grades 8 to 12 in high schools in Cape Town found that 93% owned a mobile phone (Oosterwyk & Parker, 2010), and that the learners primarily used their mobile phones to access mobile Internet applications (e.g., Facebook) and mobile social networks (e.g., Mxit) to link with peers and family. The Oosterwyk and Parker (2010) study also revealed that with the adoption of mobile phones by learners in Cape Town, there was an increase in the number of learners being cyberbullied. Similarly, Kruger's (2011) qualitative research in one school in the Western Cape Province established that cyberbullying had become a significant issue in schools and educators were struggling to deal with it in the absence of rules or strategies in place to mitigate the problem.

Findings from the aforementioned UNICEF-commissioned study (Beger & Sinha, 2012) found that the main online risks faced by South African 15- to 24-year olds were cyberbullying, sexting, and meeting strangers online. A more recent study (Alfreds, 2013) reported that the full extent of cyberbullying in South Africa is not known, but that it is definitely growing. Evidence from the Alfreds (2013) study has suggested that young people in particular are exposed to cyberbullying.

Accordingly, the South African government and private-sector actors have initiated projects that blend the promotion of both ICT development and online safety (De Lange & Von Solms, 2011). With the number of South African ICT users growing rapidly, especially among low-income user sectors not previously well-connected to the digital world, there is an urgent need for well-structured policymaking in support of ICT development that balances the imperatives of education and e-safety.

RESEARCH FINDINGS

A total of 324 students were targeted by the study, and Table 1 below provides grade and gender breakdowns for the students.

TABLE 1: GRADE AND GENDER BREAKDOWNS OF TARGETED RESPONDENTS (N = 324)

Grade	Number in Sample (n)	Gender		
		Male	Female	Prefer not to say
Grade 10	83	38	41	4
Grade 11	82	28	52	2
Grade 12	159	53	94	12
Total	**324**	**119**	**187**	**18**

Of the 324 students in the target sample, 310 completed the survey. The ages of the respondents ranged from 15 to 21 years old, and 87% of respondents (n = 271) were between the ages of 15 and 18. As outlined in Table 2, of the 310 respondents, more than half (60%) were female, 35% were male, and 5% chose the "Prefer not to say" response when asked their gender. It is unclear why these students chose not to identify their gender in a simple binary choice. This reluctance could relate to gender issues connected to experiences of cyberbullying – for example, heteronormativity, monosexuality and homophobia (Pawelczyk et al., 2014). These issues could be addressed in future research. (Research into questions of sexuality in schools is important and necessary, and school children need to be provided with the knowledge and skills to challenge and deal with homophobic behaviour (Pawelczyk et al., 2014)).

TABLE 2: GENDER BREAKDOWN OF RESPONDENTS (N = 310)

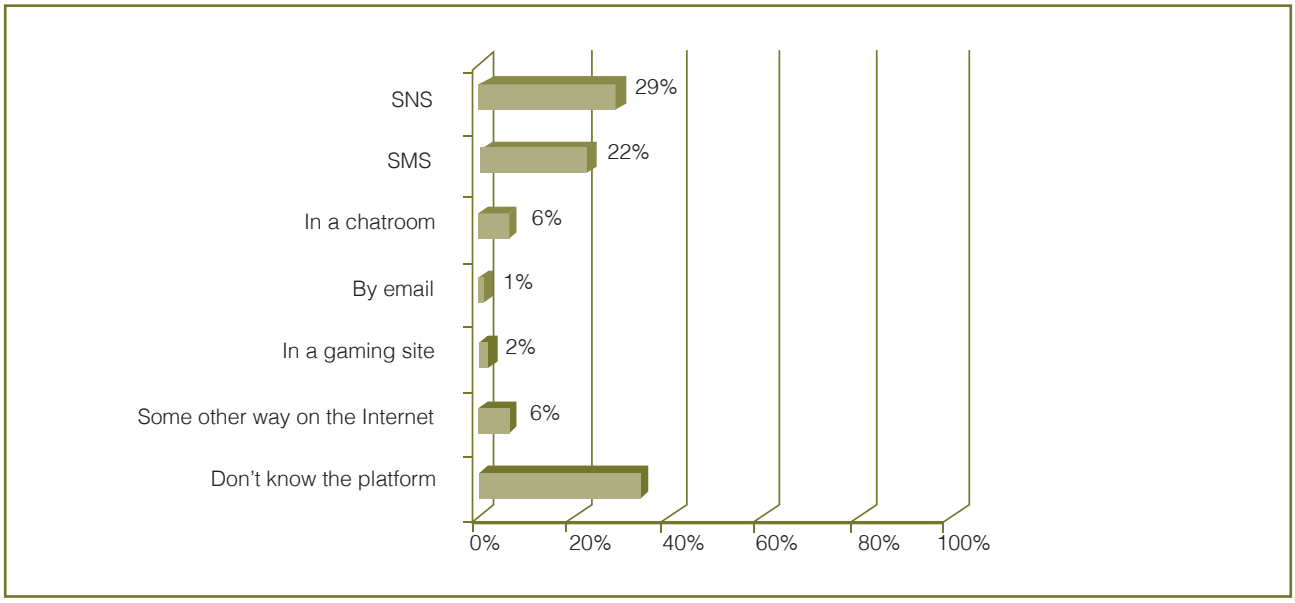
Gender	n	%
Male	108	35
Female	185	60
Prefer not to say	17	5
Totals	**310**	**100**

The number of questions answered by participants depended on their experience of cyberbullying. In response to the question regarding if they had been bullied online (on the Internet or SNSs) in the previous 12 months, 42% (n = 131) stated that they had (Table 3). The next question related to specifics of the platforms on which they had experienced cyberbullying.The highest frequency (29%) of response was SNSs, and the second-highest (22%) was SMS (see Figure 2 below). This finding reinforces the results of the aforementioned Nelson Mandela Bay study by De Lange and Van Solms (2011), which also found that SNSs were the most-used platform for cyberbullying amongst South African high school students, with SMS a close second.

TABLE 3: RESPONDENTS EXPERIENCING CYBERBULLYING IN THE PREVIOUS 12 MONTHS (N = 310)

	n	%
Bullied online	131	42
Not bullied online	180	58
Totals	**310**	**100**

FIGURE 2: PLATFORM WHERE CYBERBULLYING WAS EXPERIENCED (N = 131)



Respondents were also asked about the specifics of cyberbullying incidents and their experiences as cyber victims. They were provided with a list of possible experiences and could select more than one response. (Out of the 144 responses to this question, 127 indicated their gender, and for purposes of analysis those who did not disclose their gender were ignored.) As outlined in Table 4, among the 127 male and female (M+F) responses to this question, 24 had "nasty or hurtful" messages sent to them.

Of the 24 respondents who said they had received nasty or hurtful messages, three-quarters (n = 18) were female and a quarter male (n = 6). As Table 4 shows, there was in fact a higher percentage of females than males for each of the experiences listed. But a Chi² goodness-of-fit test was done (see Table 5) to determine whether the percentages by gender per form of bullying differed significantly from the gender percentage for the sample (i.e., the sample was 63% female and 37% male). The Chi2 results showed that the gender differences were in fact *not* statistically significant for this sample, i.e., the data did not statistically confirm that females experienced more cyberbullying incidents online than males.

TABLE 4: SPECIFICS OF CYBERBULLYING EXPERIENCE AS VICTIM

	Male		Female		Males + females (M+F)		Prefer not to say		Totals	
	n	% M+F	n	% M+F	n	% Totals	n	% Totals	n	%
Nasty or hurtful messages were sent to me online	6	25%	18	75%	24	96%	1	4%	25	100%
Nasty or hurtful messages about me were passed around or posted online	2	15%	11	85%	13	100%	0	0%	13	100%
I was excluded from a group or activity online	4	29%	10	71%	14	93%	1	7%	15	100%
I was threatened online	3	38%	5	63%	8	89%	1	11%	9	100%
Other nasty or hurtful things online	2	25%	6	75%	8	100%	0	0%	8	100%
Something else happened online	9	41%	13	59%	22	88%	3	12%	25	100%
Don't know	15	54%	13	46%	28	88%	4	13%	32	100%
Prefer not to say	3	30%	7	70%	10	91%	1	9%	11	100%
No. of responses	**44**	**35%**	**83**	**65%**	**127**	**88%**	**17**	**12%**	**144**	**100%**

TABLE 5: CHI² GOODNESS-OF-FIT TEST RESULTS FOR SPECIFICS OF CYBERBULLYING AS CYBER VICTIM

	Chi-square	p(df = 1)	Cramer's V
Nasty or hurtful messages were sent to me online	1.47	.226	n.a.
Nasty or hurtful messages about me were passed around or posted online	2.59	.107	n.a.
I was excluded from a group or activity online	0.42	.517	n.a.
I was threatened online	Sample too small		
Other nasty or hurtful things happened to me online	Sample too small		
Something else	0.15	.699	n.a.

Respondents who reported having been cyberbullied were then asked how long they felt "bothered" by the cyberbullying experience. They were only able to select one response from a list of five possible responses (Table 6). Of the 121 responses given to this question, 25% (n = 30) reported that they "got over it straight away" and 37% (n = 45) said they felt bothered "for a few days". Only 9% (n = 11) reported that they were bothered "for a couple of months or more".

TABLE 6: DURATION OF FEELING BOTHERED BY CYBERBULLYING INCIDENT

Gender	How long did you feel bothered for?										Totals	
	I got over it straight away		I felt like that for a few days		I felt like that for a few weeks		I felt like that for a couple of months or more		Don't know how long I felt bothered			
Male	15	38%	11	28%	5	13%	0	0%	9	23%	40	100%
Female	15	21%	31	43%	9	13%	11	15%	6	8%	72	100%
Prefer not to say	0	0%	3	33%	2	22%	0	0%	4	44%	9	100%
Totals	**30**	**25%**	**45**	**37%**	**16**	**13%**	**11**	**9%**	**19**	**16%**	**121**	**100%**

Among the M+F respondents to the "duration of feeling bothered" question, the gender breakdown was evenly split (15 females, 15 males) for those who stopped feeling bothered straight away. But gender differences were found for two of the other possible answers to this question:

- among those who answered that they felt bothered for a few days, a clear majority were females (31 females compared to only 11 males); and
- among those who were bothered by the experience for a couple of months or more, all 11 respondents who gave this answer were females.

A Chi² test was performed in order to determine statistical significance of these gender differences and the "Prefer not to say" category of gender was excluded. The results (Chi2(4) = 14.29, p = .006, V = 0.36) revealed that the differences in gender groups was statistically significant. It can therefore be concluded that overall females felt bothered for a longer time than males.

Respondents who reported being cyberbullied were also asked what actions they took in response to the incident (Table 7). They were provided with a list of possible responses and could select more than one response.

TABLE 7: ACTIONS TAKEN IN RESPONSE TO CYBERBULLYING

	Male		Female		Males + females (M+F)		Prefer not to say		Totals	
	n	% M+F	n	% M+F	n	% Totals	n	% Totals	n	
I stopped going online for a while	4	25%	12	75%	16	100%	0	0%	16	100%
I deleted any messages from the person	11	31%	25	69%	36	100%	2	6%	38	100%
I changed my contact settings	2	17%	10	83%	12	100%	0	0%	12	100%
I blocked the person from contacting me	8	24%	26	76%	34	100%	1	3%	35	100%
I reported the problem	2	17%	10	83%	12	100%	0	0%	12	100%
None of these	20	51%	19	49%	39	100%	4	10%	43	100%
Don't know	5	56%	4	44%	9	100%	1	11%	10	100%
No. of responses	**52**	**33%**	**106**	**67%**	**158**	**100%**	**8**	**5%**	**166**	**100%**

The response with the highest frequency (n = 36) to the actions taken question was "I deleted any messages from the person", and the second-highest (n = 34) was "I blocked the person from contacting me". Of the 158 responses to this question who also indicated their gender, 16 stated that they stopped using the Internet for a while, and of these 16 respondents, 75% (n = 12) were female and 25% (n = 4) male (Table 7). In fact, for each of the responses, females had a higher proportion responding in the affirmative than males. But a Chi² goodness-of-fit test (Table 8 below) found that the gender differences in these results were not statistically significant given the gender split within the total sample.

TABLE 8: CHI² GOODNESS-OF-FIT TEST RESULTS FOR GENDER DIFFERENCES IN RESPONSES TO CYBERBULLYING

	Chi-square	P (df = 1)	Cramer's V
I stopped going online for a while	0.98	.323	n.a.
I deleted any messages from the person	0.63	.428	n.a.
I changed my contact settings	2.12	.146	n.a.
I blocked the person from contacting me	2.62	.105	n.a.
I reported the problem	2.12	.146	n.a.
None of these	3.45	.063	n.a.

Another question in the survey asked respondents to indicate whether or not they had cyberbullied someone else in the past 12 months. Of the 310 respondents, 187 (60%) admitted to being a perpetrator. Of these 187, 10% (n = 18) admitted to "acting nastily" online to someone "every day or almost every day" (Table 9), and 19% (n = 35) of respondents said they were nasty to someone online "once or twice a week".

TABLE 9: FREQUENCY OF BULLYING AS PERPETRATOR

Gender	How often do you act nastily to someone online?										Totals	
	Every day or almost every day		Once or twice a week		Once or twice a month		Less often		Don't know how often			
Male	7	11%	12	20%	11	18%	21	34%	10	16%	61	100%
Female	11	10%	19	17%	13	12%	45	41%	21	19%	109	100%
Prefer not to say	0	0%	4	24%	3	18%	4	24%	6	35%	17	100%
Totals	18	10%	35	19%	27	14%	70	37%	37	20%	187	100%

Among respondents to this question who also indicated their gender (M+F):

- of those who admitted to acting nastily to someone online every day (n = 18), 11% (n = 11) were female and 10% (n = 7) were male; and
- of those who reported being nasty to someone online once or twice a week, 20% (n = 12) were male and 17% (n = 19) were female.

However, a Chi² test was done with "Prefer not to say" excluded and it was found that the results (Chi2(4) = 1.86, p = .761) were not statistically significant (p > 0.05) given the gender split within the total sample.

CONCLUSIONS AND RECOMMENDATIONS

The survey results provide valuable insights into the cyberbullying experiences of a sample of Cape Town high school students. The most noteworthy findings are:

- that 47% of respondents had been victims of cyberbullying;
- that 60% of respondents had been perpetrators of cyberbullying;
- that 19% of perpetrators said they cyberbullied once or twice a week, and a further 10% said they cyberbullied every day or almost every day;
- that SNSs were the most frequent place for cyberbullying to occur, followed by SMS platforms;
- that only 25% of respondents who reported being cyberbullied were able to immediately get over feeling bothered, with 59% of respondents taking a few days, a few weeks, or a month or two or more, to get over the experience;
- that far more female respondents than male respondents took a long time (i.e., a few weeks, or a month or two or more), to get over a cyberbullying experience; and
- that no statistically significant gender difference could be found in the proportions of male and female students who reported that they had been victims of cyberbullying, that they had been perpetrators cyberbullying, or in the actions they took in response to cyberbullying.

A key finding from the literature review was that it is not the online platforms themselves that are at the core of the problem; rather, it is the human behaviours that occur via these platforms. The fundamental problems are thus human not technical. This result confirms the argument that education, guidance and mediation are required in children's use of technology and content (Lin & Atkin, 2014). The results of both our survey and our literature review highlight a need to build e-safety and anti-cyberbullying awareness and preventative action among learners, teachers and parents. Dialogue at home and in schools, between learners and parents and between learners and teachers, needs to be a central component of the awareness-raising and prevention, and the efficacy of such efforts will need to be investigated in future research.

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VALUE ADDED CONTRIBUTIONS,
NON-PEER-REVIEWED, EDITED CONTRIBUTIONS



NIGERIA'S EVOLVING PRESENCE IN CYBERSPACE

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ABSTRACT[1]
Cyberspace is now critical to every nation's socio-economic, cultural and political activities. When it is disrupted or fails, a country may experience strong adverse effects. On the contrary, its correct functioning and pliability is transforming modern society with exceptional pecuniary and social benefits. With many activities increasingly moving to the Internet, cyberspace has become a new stage for innovations, enterprises, social networking, criminality and war. This paper presents a brief overview of a study on Nigeria's presence in cyberspace. The Internet penetration growth and evolving Internet infrastructure provisioning in Nigeria were examined and a critical assessment of Nigerian presence in cyberspace was carried out between the months of August and September 2015, using the United Nations online presence index methodology. Web content, interactivity, the currency of information, downloadable documents and other data sets were used to compare various sectors of the Nigerian economy, including all tiers of government, academia and the organised private sector. The study revealed that the organised private sector and private educational institutions are doing better than government educational institutions and ministries. Actions for increasing presence in cyberspace and achieving e-governance for improved services and productivity in Nigeria and similar developing countries are recommended.

KEYWORDS
cyberspace, information economy, e-governance, cyber innovations, online presence, Internet presence

INTRODUCTION

Cyberspace has emerged as an indispensable domain for individuals, businesses and governments. Many economies use the Internet for provisioning of critical services such as governance, financial transactions, the supply of electricity, water, and delivery of goods and services in almost all sectors [1], [2]. As cyberspace is used to control, process, share, collaborate and communicate information, it is now a vital infrastructure of the 21st century. Consequently, its disruption can cause a country's economy and institutions to grind to a halt [3].

Nigeria's journey in cyberspace started without planned information systems and network infrastructure, until the establishment of a regulator, the Nigerian Communications Commission (NCC) [4]. NCC's policy and institutional reforms for the liberalisation of the telecoms sector accelerated the Internet growth and penetration rate in Nigeria. By the beginning of the 2000s, Internet penetration began to grow rapidly with the heavy importation of VSAT technology across the country and the popularisation of Internet cafés. Thereafter, the three international submarine cables, namely SAT3, GLO1 and MainOne, provided access to the global Internet. Subsequently, the introduction of Global System for Mobile communications (GSM) technology contributed to the explosion of Internet access with the roll-out of 3G mobile technology. Presently, mobile Internet bandwidth accounts for about 55% of Internet connectivity in Nigeria, with over 80 million Internet users as at October 2015 [5], [6]. The Nigerian cybercitizen represents 2.3% of world Internet users, with Nigeria ranked eighth in the world for number of Internet users [5]. Nigeria has consistently maintained its lead in the growth of the number of Internet users in Africa, although as engagement in cyberspace is increasing as the mainstream of human enterprise, cyber-criminality is also increasing at a fast pace worldwide.

This paper examines Nigeria's evolving presence in cyberspace and its prominence in terms of emerging, digitally driven society. The United Nations' four-stage model framework for benchmarking the various stages in evolution of e-government services of countries is utilised to investigate the web presence of various tiers of Nigerian government, ministries, as well as tertiary institutions and the organised private sector [7]. Based on international best practice, a list of imperative actions is proffered for improving the cyberspace presence of Nigeria and other sub-Saharan African countries, so as to achieve security and economic sustainability.

ONLINE PRESENCE SURVEY OF NIGERIAN ORGANISATIONS

In gauging Nigeria's presence in cyberspace, a detailed survey and analysis was conducted, comparing various websites. The UN online presence index methodology (2012) was adopted to generate an online index [7], [8], [9]. The survey was carried out in August and September 2015. The online index was derived by grading each website based on the following characteristics: essential information and content of the site, currency of information, downloadable documents, newsletters, reports and databases. The interactive nature of the site (ability to receive feedback from clients, customers), blogs, chat forums, help features, two-way communication on the site, response to emails, and

1 This paper is a shortened and edited version of the paper titled "A critical assessment of Nigeria's presence on the cyberspace", presented at CyberAbuja 2015, International Conference on Cyberspace Governance: The Imperative for National and Economic Security, Abuja, 4 to 7 November 2015. References are retained in IEEE style as in the conference paper.

language translations were also investigated. The sectors investigated were government, academia, finance, business, oil and gas, and telecommunication industries.

These features were categorised into stages of evolution. Stage One implies a website presence with necessary information, but not frequently updated. Stage Two applies to constantly updated websites with downloadable materials that are current. Stage Three represents a website that allows for two-way communication with users and where transactions can be conducted. Stage Four is applied to classify a website that is a one stop shop where access to all the necessary information is present, in various languages, to all users at home and abroad.

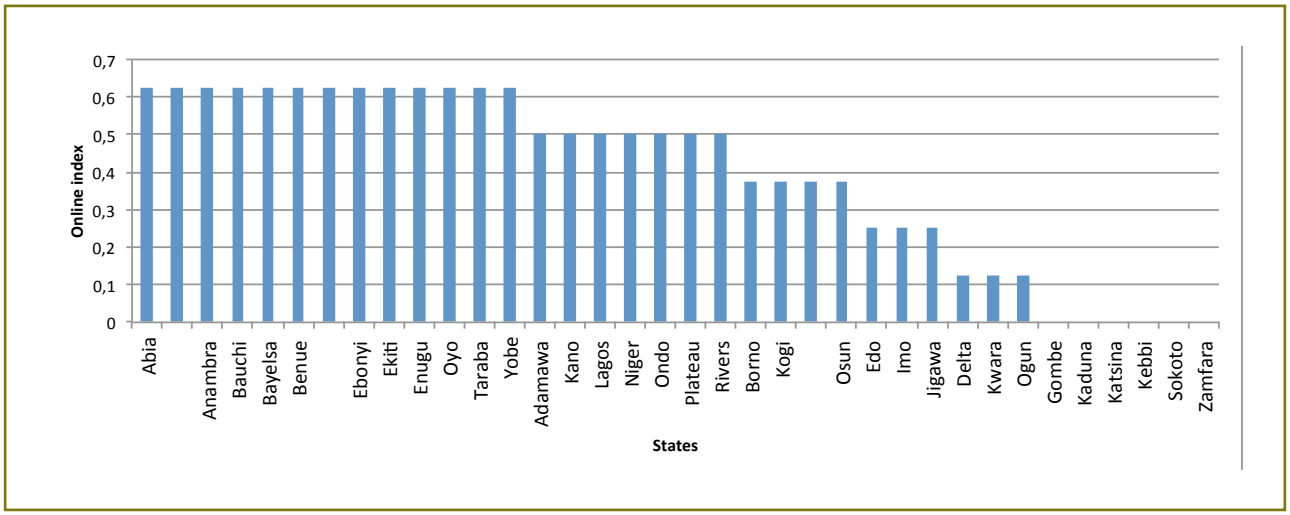
Online index values of 0 to 0.25 were assigned to websites at Stage One, values of 0.25 to 0.5 were given to websites at Stage Two, an index of 0.5 to 0.75 was assigned to websites at Stage Three and an index of 0.75 to 1 was applied to websites at Stage Four.

RESULTS

STATE GOVERNMENTS

Figure 1 reflects the web presence of the 36 states, including the Federal Capital Territory (FCT). About 36% were in Stage Three, while one out of every six states was not online. Most of the states with no web presence are the northern states of Nigeria.

FIGURE 1: WEB PRESENCE OF NIGERIA STATE GOVERNMENTS



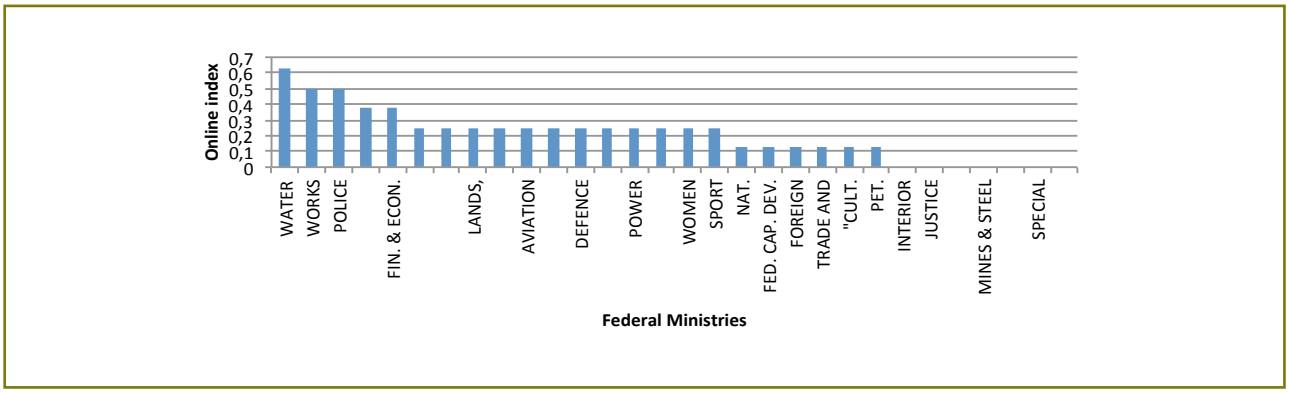
LOCAL GOVERNMENT AREAS (LGAS)

The survey revealed that of the 774 local government areas, only 28 LGAs had any form of web presence. All these local governments were found in one state, Akwa Ibom. The absence of a website for most LGAs, the level of government closest to communities, is a major weakness in Nigeria's online presence.

FEDERAL MINISTRIES

The results reveal that only one Ministry is at Stage Three, while the majority are at Stage One (Figure 2). Out of the 30 ministries surveyed, seven (23%) had no web presence. This is in contrast to the survey results of 2014, which indicated that all Ministries had an online presence [10], making access to government easier and available to more citizens.

FIGURE 2: ONLINE PRESENCE OF FEDERAL MINISTRIES



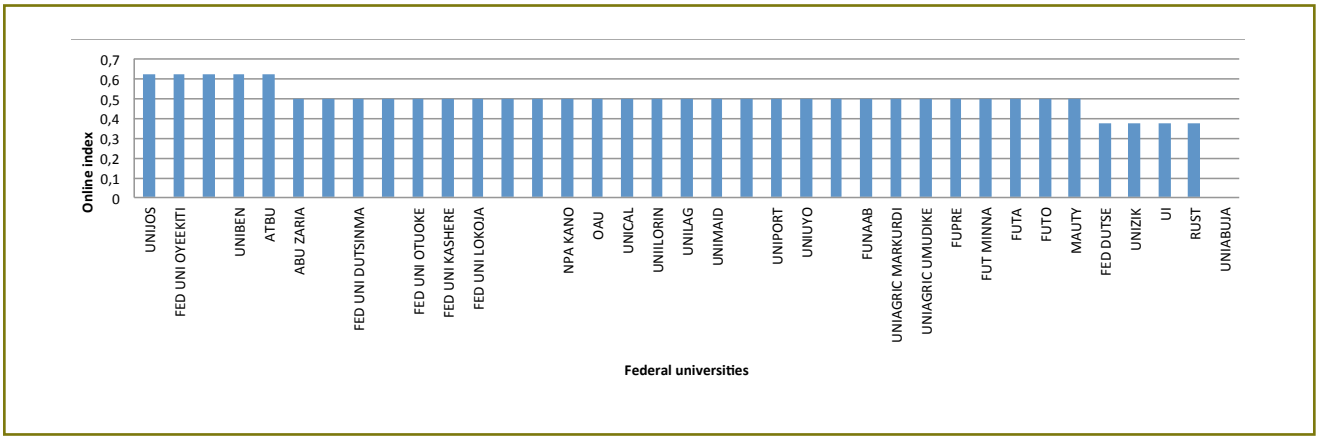
TERTIARY INSTITUTIONS

Given the large number of tertiary institutions, the results of the survey were categorised into various groups, namely universities (federal, state and private), polytechnics and colleges of education (CoEs).

UNIVERSITIES

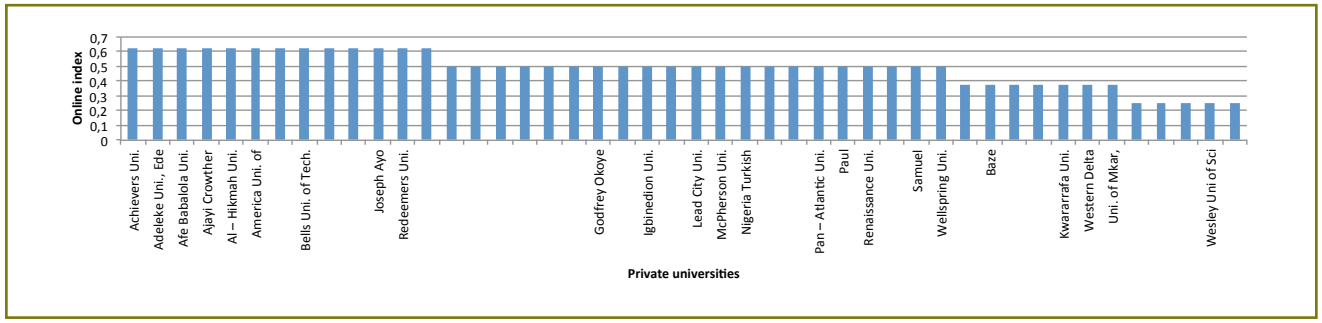
The survey revealed that more federal universities are participating in the many benefits of cyberspace, with more than 97% being online, to enable them to provide e-services such as online result checking, registration and payment of fees (Figure 3). Although, some have reached Stage Three, they are yet to become one-stop shops where all that is needed from the university (information and otherwise) is available online.

FIGURE 3: ONLINE PRESENCE OF FEDERAL UNIVERSITIES



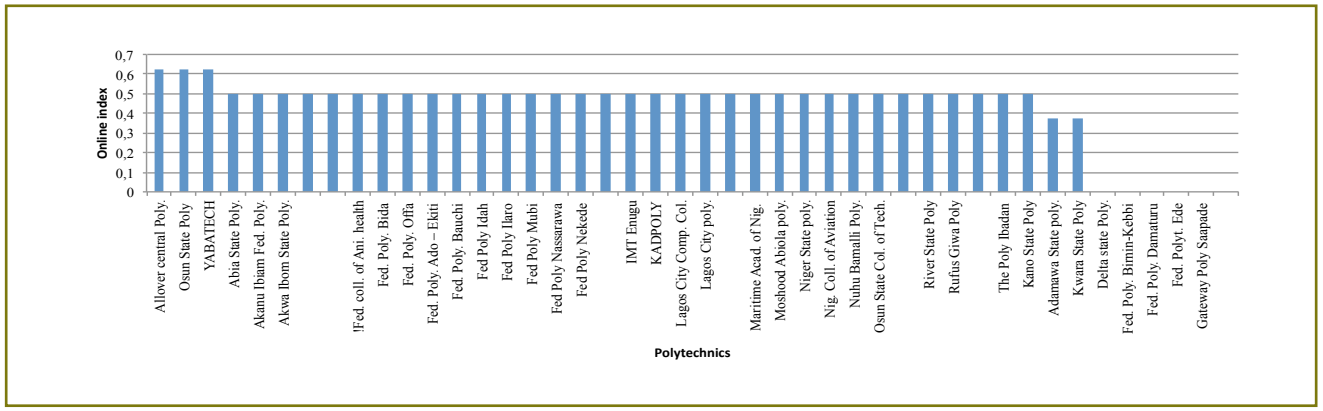
Although most of the state universities investigated have reached Stage Two, with some necessary web features, about 16% are yet to have any form of web presence (Figure 4).

FIGURE 4: WEB PRESENCE OF STATE UNIVERSITIES



It is important to note that the private universities have latched onto the many benefits of having a web presence. All the 46 private universities surveyed had web presence, with the majority at Stage Two and 28% at Stage Three (Figure 5).

FIGURE 5: ONLINE INDEX OF PRIVATE UNIVERSITIES



POLYTECHNICS AND COLLEGES OF EDUCATION

The investigation of polytechnics revealed that of the 44 polytechnics studied, five were not on the web (Figure 6). It is worthy of note that most of the polytechnics, namely 88%, have a web presence and 84% have a Stage Two web presence. Of the 34 colleges of education surveyed, only 68% have any form of web presence (Figure 7). This is very low compared with that of universities and polytechnics. In total, 153 public tertiary institutions were surveyed and 15% had no form of web presence.

FIGURE 6: ONLINE PRESENCE OF POLYTECHNICS

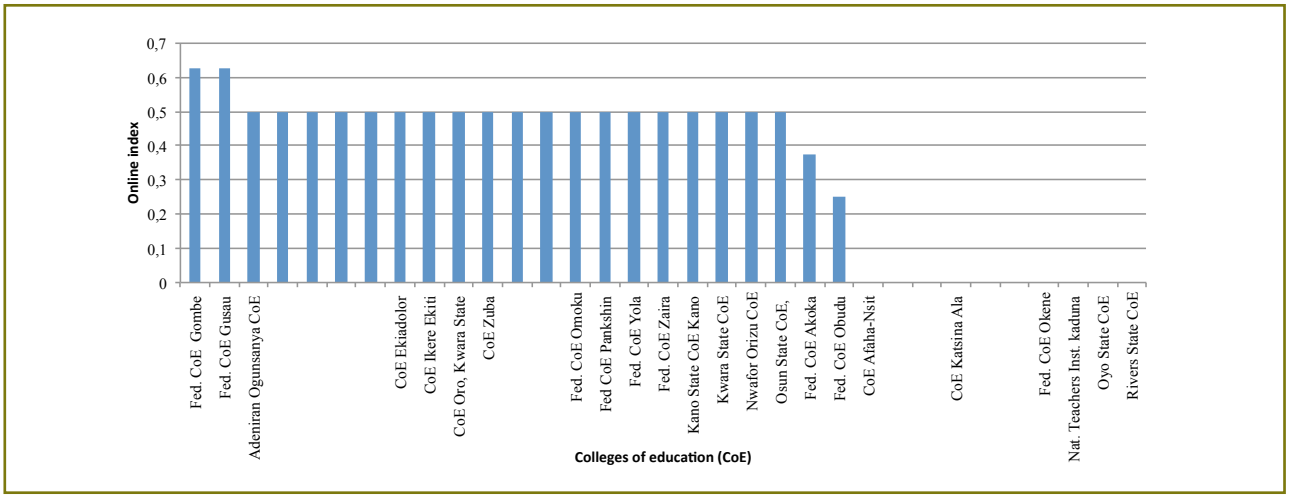
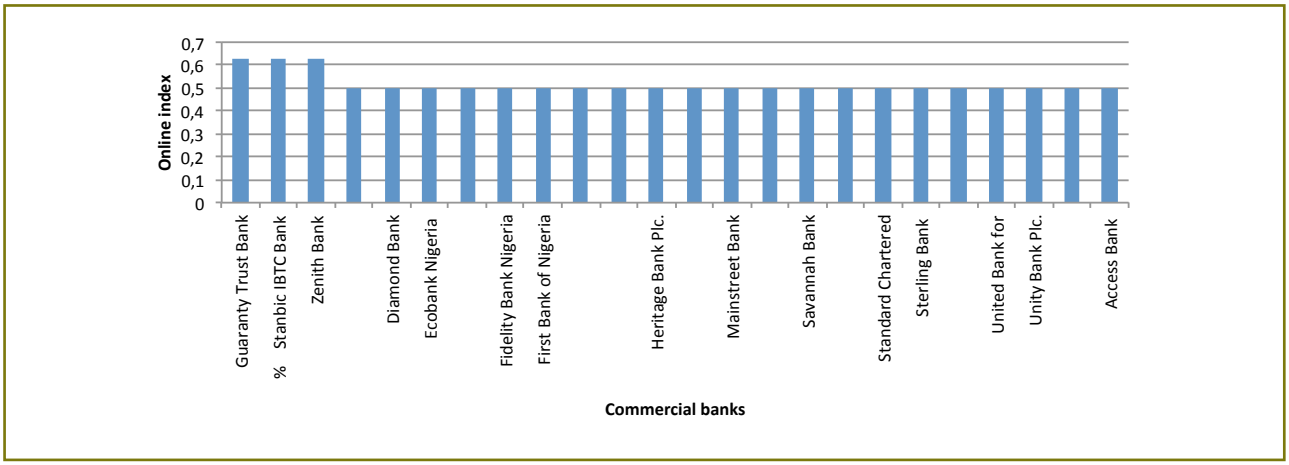


FIGURE 7: WEB PRESENCE INDEX OF COLLEGES OF EDUCATION (COE)



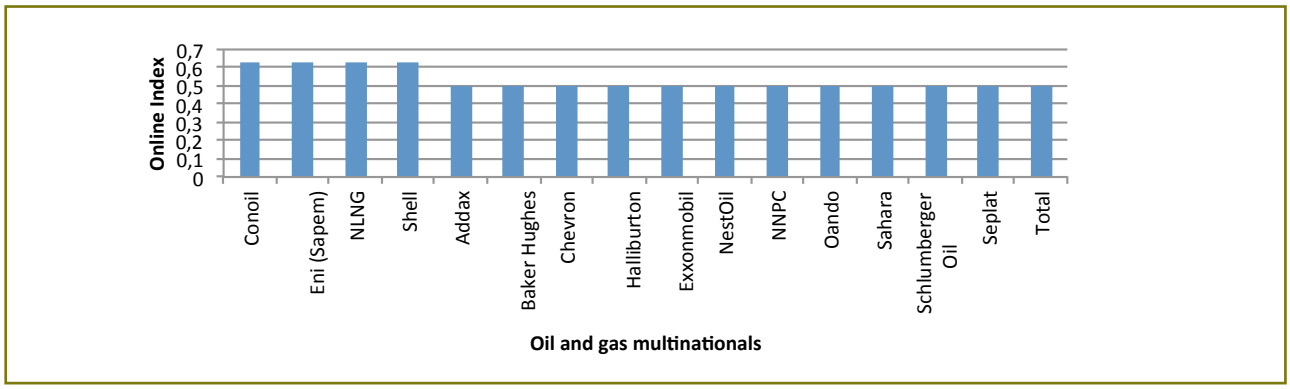
SECONDARY SCHOOLS

The secondary schools have embraced the use of Cyberspace. Out of the 24 Federal Government Colleges investigated, 62.5% were online, with features between Stage One and Stage Two. This is encouraging when compared with the previous survey carried out in 2014 [10].

BUSINESSES AND FINANCIAL SECTOR

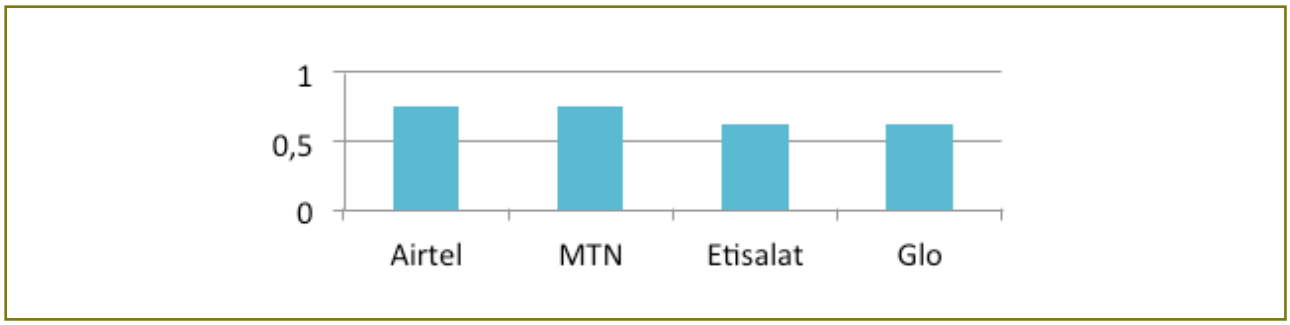
Microfinance and other banks that were investigated revealed that of the 88 micro finance banks surveyed, only 11 (12.5%) of them had any form of web presence. Commercial banks all make use of the Internet to do business with customers (Figure 8).

FIGURE 8: ONLINE INDEX OF COMMERCIAL BANKS



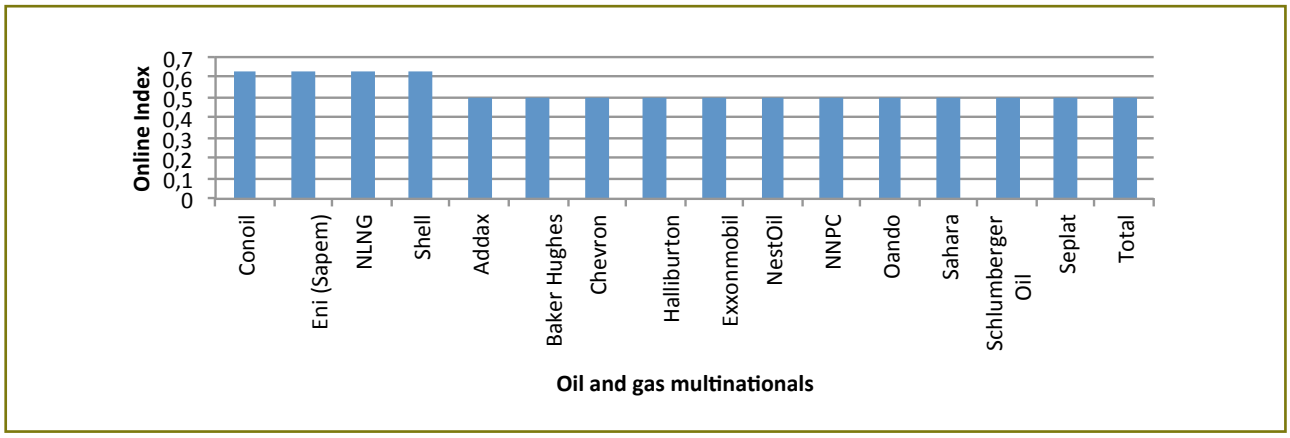
The online presence of mobile phone companies reveals that all are online, and they have keyed into providing excellent e-services to their customers (Figure 9).

FIGURE 9: TELECOMMUNICATION COMPANIES ONLINE PRESENCE



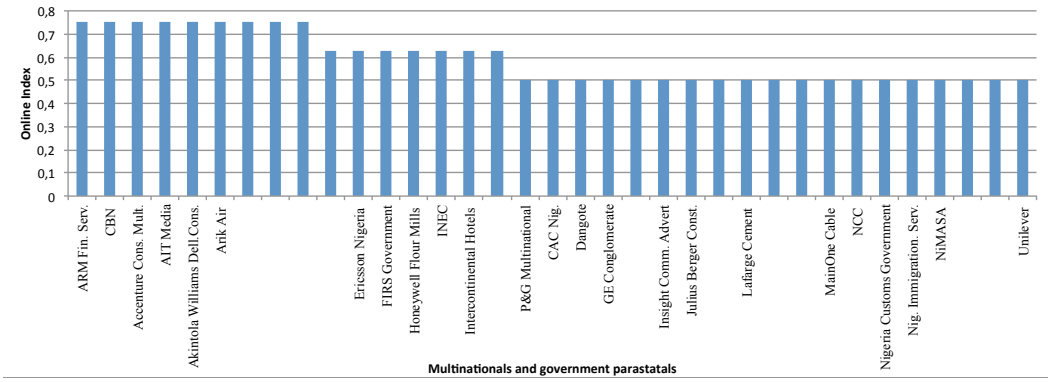
As seen from Figure 10, the multinational oil and gas companies have functioning websites that are rated at Stage 2. They have all bought into the benefits of doing business online.

FIGURE 10: OIL AND GAS MULTINATIONALS WEB PRESENCE INDEX



A few multinational companies that provide services ranging from manufacturing to information technology services were investigated and their online presence is as shown in Figure 11. All the companies and parastatals investigated (35) were seen to have web presence.

FIGURE 11: ONLINE INDEX FOR SOME MULTINATIONALS AND GOVERNMENT PARASTATALS



DISCUSSION

The outcome of the survey carried out during August to September 2015 depicts a significant online presence of states, private universities, public tertiary institutions, multinational companies, businesses and commercial banks, but a very low web presence for ministries, local governments and microfinance banks. This is not beneficial for organisations that deal directly with grassroots communities. The LGAs, who have a key role to play in providing grassroots information on basic items such as numbering of houses, taxes on shops, cleaning and maintenance of roads, healthcare, primary and adult education, birth, death and marriage certificates, must move swiftly towards greater online presence.

The future of Nigerian cyberspace is promising because there are several application areas for e-government that would yield profit and sustainable development, such as payment of taxes, import duty, government fines, feedback from communities and stakeholders, and other. The organisations and businesses that have already adopted e-administration are realising the benefits and delivering improved quality of service to their customers. This is evident in the survey conducted on businesses, as 100% of the manufacturing firms investigated exhibited above Stage Two e-presence. The financial sector offers further evidence of the success of e-administration, as most banks offer e-services to their customers and have integrated their ICT infrastructures so that transactions can be done from any bank branch. This is in addition to the integration of ATM facilities and mobile banking for various banks, so that customers can withdraw cash from any ATM, or use their smartphones for banking, irrespective of their bank. Thus, e-governance and ICT infrastructure have produced significant digital change in the banking and organised private sector. The emergence of the Nigerian cybercitizen and the growth and penetration rates of Nigeria's Internet usage are also important indicators of the encouraging healthy growth of Nigerian cyberspace.

With the increasing adoption of e-administration in the tertiary institutions, the positive impact felt in the banking environment can be replicated in universities, polytechnics and colleges in the areas of improved teaching and learning, research and development, planning and projection, accountability and administration. Dramatic life-changing benefits can be realised if appropriate ICT infrastructure is provided in the tertiary education system [8].

For sustainable economic development to be realised, there must be citizen feedback. From this study, Nigerian websites are yet to provide this feature, noting that information dissemination is still one way, from government to citizens. Those living in LGAs in rural areas and some towns do not even have the necessary ICT infrastructure to access the websites.

Presently, application forms for government and organisational use can be filled in online, thereby reducing the cost of travel and risk of life, Thus some of the benefits of e-governance, such as reduction in cost of governance, equality of access to information, elimination of bureaucracy, and efficient service delivery, are beginning to be realised.

At the time of the study, very few small and medium enterprises in Nigeria had websites and thus could not be reached by the global community for e-commerce. Future access to ICT infrastructure can boost such businesses with greater profits and more job creation.

On cybersecurity, the Federal Government of Nigeria has recognised the importance of cybersecurity and has introduced several initiatives. In 2004, the Nigerian Cybercrime Working Group (NCWG) was established, a 15-member committee drawn from government and the private sector to look into the legal and institutional framework for addressing cybercrime in Nigeria [11]. The Committee developed the first Bill on Cybercrime and Critical Information Infrastructure Protection, which was conveyed to the National Assembly, although sponsored by a private individual. However, the Bill suffered an inexplicable setback. In 2011, a National Committee was set up by the National Security Adviser charged with the responsibility to harmonise the various cybersecurity bills pending in the National Assembly. The draft Cybersecurity 2011 Bill was finally signed into law in 2015. The National Cybersecurity Policy and Strategy was launched in March 2015. Some federal government institutions are confronting cyber-criminality aligned with their constitutional mandates.

The Economic and Financial Crimes Commission (EFCC), established in 2003, is also fighting all sorts of digital financial crimes. EFCC works in collaboration with the Financial Action Task Force on Money Laundering (FATF), an intergovernmental organisation. The Independent Corruption Practices and other Related Offences Commission (ICPC), established in 2000, has the mandate to receive and investigate reports of corrupt offences as created by the Act, and in appropriate cases, prosecute the offender(s).

In the same vein, the Central Bank of Nigeria, regulating the banking industry, has set out frameworks as policy direction towards confronting the menace of digital fraud in the banking sector. The latest of these initiatives is the biometric verification number (BVN), established in 2014 as a centralised biometric identification system for the banking industry. The BVN provides a unique identity that can be verified across the Nigerian banking sector and other financial institutions as part of the Know Your Customer (KYC) programme.

Whether the activities of these institutions are yielding the expected results is open to debate. Undoubtedly, the use of ICT is becoming a game changer. Recommendations to improve the present scenario are given in the following section.

RECOMMENDATIONS

In view of the fact that cyberspace is now critical to every nation's safety, socio-economic and political activities, the sub-Saharan African countries need to work together to provide the necessary legislation and agreements to support e-governance across the region. Itemised below are specific imperative actions for improving the cyberspace presence of Nigeria, also pertinent to other sub-Saharan African countries.

i. **National ICT regulators:** These should ensure that all government organisations and educational institutions adopt e-governance process workflows and applications. This is in addition to having a cybersecurity policy that is regularly updated. By e-governance is meant the processes associated with online governance of institutions, economy and society.
ii. **Provision of affordable broadband infrastructure:** For Nigeria, the FGN National Broadband Plan is commendable and implementation should be given top priority. e-Governance and e-business cannot be achieved with the present slow and expensive Internet access.
iii. **Proper financing of ICT infrastructure:** The initial cost of ICT infrastructure is usually high. Strategic, targeted ICT infrastructure funding should be made available through national budgets, but should not crowd out private sector investment. It is also important to budget for support and maintenance costs. The digital divide is rooted in the lack of e-infrastructure, which has hindered information use and knowledge creation.
iv. **Appropriate staffing and establishment of ICT units in organisations:** The establishment of ICT departments in all ministries and parastatals at the federal, state and local government levels should be made mandatory.
v. **Provision of steady power supply:** Renewable power supply (solar and wind) should be used for ICT installations. Computers and networks need clean power to function optimally.
vi. **Provision of a secure experience for web visitors:** Any computer connected to the Internet is vulnerable to virus infection or attack. There should be a call centre with a phone number and email address, where cybercrime can be reported.
vii. **Vulnerability and threat assessments:** These must be carried out regularly on all government ICT infrastructure. This is in addition to having robust business continuity and disaster recovery plans that are regularly tested.

CONCLUSION

For Nigeria, there exists a digital divide within the country, as seen from the survey conducted. Some Federal Ministries and states have a Stage Two online presence, while the LGAs are generally yet to commence e-governance. Most tertiary institutions have established web presence, while very few secondary schools have keyed in. Similarly in the business sector, most multinationals and banks are enjoying the benefits of e-business, while microfinance institutions are lagging behind.

With economic and social activities increasingly moving to the Internet, cyberspace has become the platform for innovations, enterprises, social networking, criminality and war. Nigeria and some other West African countries have started moving towards an increased online presence. It is vital for Nigeria and other sub-Saharan African countries to learn from global best practice and collaborate to develop a harmonised framework with necessary defense against cyber-criminality and cyber-warfare.

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STATE OF INTERNET OF THINGS DEPLOYMENT IN AFRICA AND ITS FUTURE: THE NIGERIAN SCENARIO[1]

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INTRODUCTION

Internet of things (IoT) refers to an intelligent network of connected objects for the purpose of communication, actuation, data aggregation and information processing. Currently in Africa there is a slow rate of adoption of IoT compared with other continents. Nigeria, as the biggest mobile market and most populous African country, has enormous prospects in IoT, which if effectively implemented, is likely to bring about increased productivity across all economic sectors and an improved standard of living for the people. This paper looks at the current state of IoT deployment in Nigeria, the challenges faced and the opportunities that abound.

SUCCESS FACTORS FOR IOT DEPLOYMENT IN NIGERIA

With seven mobile operators and a population of about 170 million people, Nigeria had 85 million subscribers as at June 2015, and is the largest mobile market in the Economic Community of West African States (ECOWAS), accounting for more than half of the sub-region's subscriber base [1]. One of the success factors affecting the deployment of IoT in Nigeria is the low cost of electronic components and services. Sensor prices have dropped to an average of 60 cents from USD1.30 in the past 10 years, while the cost of bandwidth has also declined steeply, by a factor of nearly 40 times over the past 10 years [2]. In like manner, the cost of processing has seen a sharp decrease of nearly 60 times in the past 10 years, thereby allowing more devices to smartly handle all the new data they are generating or receiving. With the recent introduction of big data analytics, the millions of data sets turned out daily by the various connected "things" in the IoT network can be processed faster and better. New technologies for energy conservation, such as energy harvesting and ultra-low power devices, are a key enabler for IoT, as they assure a reduced power requirement in areas like Nigeria where power supply is unreliable and sometimes infrequent.

STATE OF IoT DEPLOYMENT IN NIGERIA

According to the National Information Technology Development Agency (NITDA), the prime agency for national development of information technology (IT) in Nigeria, IT used in all economic sectors currently contributes about 11% to the gross domestic product (GDP) of Nigeria and has the potential of increasing to between 17 and 20% by the first quarter of 2016 [3]. This can be achieved with Nigeria's commitment to the development of Internet of Things and Machine-to-Machine connections. Such commitment has been indicated by Nigeria's decision to be the Official Country Partner for Africa at the Gulf Information Technology Exhibition (GITEX) in 2014 [4].

A recent research survey reports that only 30% of enterprises in Nigeria have implemented Machine-to-Machine (M2M) technology, a subset of Internet of Things, in some form or the other, with security monitoring, fleet management and point-of-sale machines currently accounting for the majority of M2M connections in Nigeria [5]. Advanced M2M applications such as smart metering, pay-as-you-drive insurance and intelligence building are not currently widely used in Nigeria, with connectivity and the complexities involved in implementing and managing such technologies serving as the key inhibitors [6].

One of the most common forms of M2M adoption in the country is car tracking and fleet management. Companies, including MTN and Vodacom Business Nigeria, offer services in these fields with features such as real-time tracking over maps, fuel level and consumption monitoring, geo-fencing, web-based access and report download, among others [7] [8]. An economic security application of IoT is the tracking of oil tankers and vessels by the Nigerian National Petroleum Corporation (NNPC). With vehicle tracking and fleet management solutions, the Corporation now has the ability to monitor vessels from the loading port to the discharge port, know their travelling speeds, the exact coordinates, destination and expected time of arrival [9].

Another form of M2M adoption in Nigeria is visible in the fight against fake and substandard medicinal drugs and pharmaceuticals by the National Agency for Food and Drug Administration and Control (NAFDAC). The agency has deployed technologies such as TruScan, Black Eye, Radio Frequency Identification (RFID), Mini Lab and Mobile Authentication Service in the fight against fake medicinal drugs and pharmaceuticals. While TruScan is a hand-held device for on-the-spot detection of counterfeit medicines, Black Eye is bench-top equipment using infrared technology to detect fake medicines. On its part, the RFID is used for verification of regulated products and other sensitive documents. The MAS technology is also known as Scratch and Text Messaging System. It enables consumers to confirm whether the drug they intend to purchase is genuine or not, through the use of a mobile phone. The Mini-Lab test kit is a reliable, simple and inexpensive method of detecting counterfeit medicines [10].

Furthermore, as part of an ambitious strategy to transform agriculture, the Growth Enhancement Support (GES) initiative, introduced in 2012, uses farmers' cellphones as electronic wallets – distributing vouchers amounting to a 50%

1 This journal contribution is a revised version of the conference paper titled "Internet of Things for Africa: Challenges and opportunities, presented at CyberAbuja 2015, International Conference on Cyberspace Governance: The Imperative for National and Economic Security, Abuja, 4 – 7 November 2015. References are retained in IEEE style as in the conference paper.

subsidy for purchase of fertiliser. Ministry officials say the phones could eventually be used for multiple purposes, from communicating weather and climate information to accessing market data. Experiences in other African countries show that such uses can deliver higher prices to farmers. Records also show that 1.2 million farmers received their subsidised fertiliser and seeds through cellphone vouchers in 2013, resulting in the addition of 8.1 million metric tons to Nigeria's domestic food supply. As a result, Nigeria reduced its food imports by over 40% by 2013, moving the country closer to self-sufficiency in agriculture [11].

Another way in which M2M connectivity is experienced in Nigeria is in the deployment of point-of-sale (PoS) terminals. A PoS terminal is an electronic device that is used for verifying and processing credit card transactions, which transmits data over a standard telephone line or an Internet connection. The Nigeria Interbank Settlement Services (NIBSS) had observed in its recent report that PoS is the most popular non-cash payment channel, preferred among the non-cash payment options by 93.6% cent of merchants and 35.8% cent of consumer usage. It described the usage of card and PoS as fair, with an average of three to four out of every 10 customers requesting to pay for transactions by card/PoS. However, the report said only 3.1% of consumers cited card/PoS as their preferred payment option, attesting to the low usage of PoS [12]. Electronic payment through PoS terminals has risen by 191 percent to N241 billion in 2014 [13].

The PCB and Microelectronics Centre, a department under the Nigerian Satellite Company Limited (NigComSat), has successfully designed, implemented, tested and deployed an RFID-based Staff Attendance and Access Control System (RFID-SAACS). RFID-SAACS is a vital tool for staff management, administration, and monitoring that will impact on staff attitude to work, as time theft by staff will be completely eliminated. The logged data can also serve as a means of staff monthly appraisal, while an additional utilisation of the RFID-SAACS system includes integration into the payroll system to facilitate precise salary computation and payment based upon vetting of employees' overall performance [14].

One of the most important applications of IoT in Nigeria was the use of RFID cards and readers in the 2015 general elections. The technology was used to check the authenticity of voters in the elections and greatly improved the credibility of the process by its ability to detect fake and cloned Permanent Voter Cards (PVCs), thus curbing massive thumb printing and the undemocratic and unconstitutional culture of political parties purchasing PVCs from voters with the aim of committing electoral fraud [15].

An important application of the Internet of Things to Nigeria is the use of Unmanned Aerial Vehicles (UAVs) in the fight against terrorism. Nigerian military sources have singled out the use of drones in the fight against Boko Haram as one of the most important factors in the recent victories of the military. The drones are said to have enhanced the surveillance capability of the army by providing real time transmission of the battlefield and in helping with the identification of terrorist camps [16] [17].

Another use of UAVs is in the fight against oil theft and pipeline vandalism. Nigeria loses 50,000 barrels of crude oil to oil theft every day, and has lost no fewer than 360 combined staff of the Nigerian National Petroleum Corporation (NNPC), the Nigerian Police and members of the community to oil theft in one year. The NNPC plans to incorporate drones as part of its measures to check the movement of vessels within Nigerian territorial waters. This measure is aimed at enhancing transparency and accountability in the oil and gas industry, as well as to boost production capacity in the sector [18].

In order to meet the diverse needs of drones in Nigeria, the Nigerian Airforce (NAF) unveiled Nigeria's first Indigenous Unmanned Aerial Vehicle (IUAV) to combat insecurity in the country. The IUAV, code named "Gulma", is capable of performing both military and civil roles such as surveillance, disaster management, convoy protection and maritime patrol. It is also capable of performing policing operations, pipeline and power line monitoring, border patrol and weather forecasting [19].

Other deployments of M2M connectivity in Nigeria include the use of pre-paid meters in the electricity industry. The benefits of the meter include an increase in revenue to the electricity company by reducing the overheads that usually characterise house-to-house recovery of revenues, and by also reducing administration cost required in its deployment. It helps the electricity company to determine the actual energy demand, while giving fair bills, control and reliable electricity to consumers [20].

Mobile phones have been used to help teachers improve English language literacy among primary school students in Nigeria. The project was launched by UNESCO and Nokia in 2013, with support from the British Council and the National Teachers' Institute of Nigeria. Participating teachers signed up for a mobile service called "English Teacher", which sends teachers educational content and messages with pedagogical advice once a day. The messages are organised into thematic modules and include images and exercises. The service runs on the popular Nokia Life+ platform and is one of the first attempts to employ mobile technology as tools for primary school teachers [21].

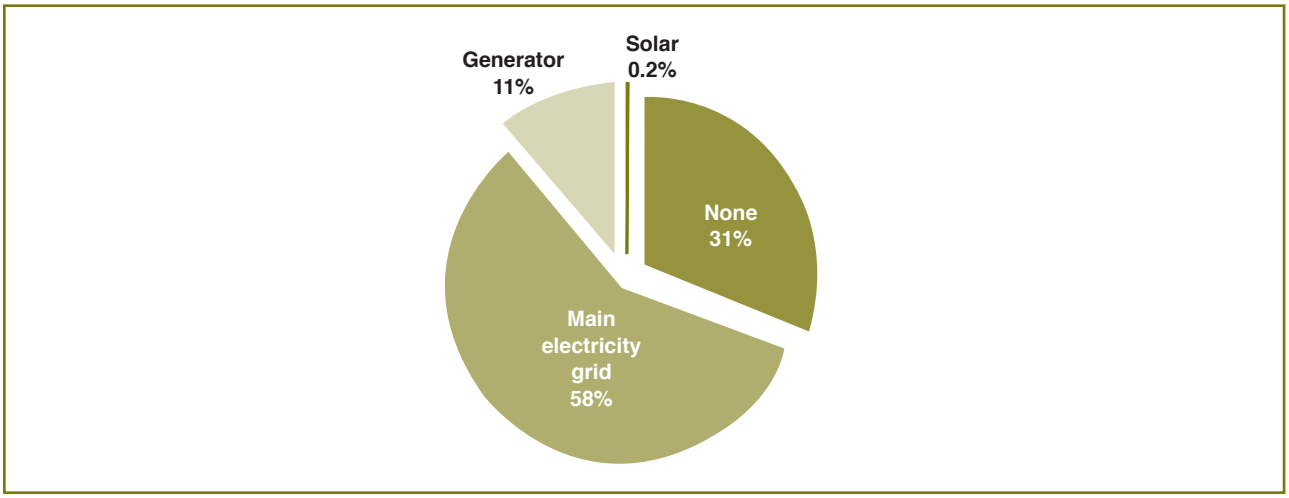
CHALLENGES TO THE DEPLOYMENT OF INTERNET OF THINGS AND MACHINE-TO-MACHINE CONNECTIONS IN NIGERIA

With respect to IoT deployment in Nigeria, most applications are at the nascent and experimental stages and there has not been a full technical and industrial grasp of its numerous opportunities due to several challenges. One of the main challenges to the deployment of IoT and M2M technology in Nigeria is the poor quality of service from network providers.

While there is little doubt that electronic communications is playing an increasingly critical role in the economic development of Nigeria, there are currently incessant complaints from customers on poor quality of service (QoS) [22]. The International Data Corporation (IDC) believes that connectivity will be a major driver for the future adoption of M2M and the Internet of Things (IoT) in Nigeria [5].

Another limitation to the growth of IoT and M2M in Nigeria is poor power supply. The Nigerian Association of Energy Economists (NAEE) has noted that despite statistics indicating that 45% of Nigeria's population is currently connected to the national grid, regular supply is still restricted to about 25% of the population [23] [24]. Nigeria's power generation capacity is markedly low compared to the estimated demand of 12,800MW. Nearly a third of the households surveyed by ResearchICTAfrica (RIA) in Nigeria are not connected to the national electricity grid, as shown in Fig. 1, while eleven percent of households surveyed depend primarily on generators for power [25].

FIGURE 1: HOUSEHOLD ELECTRICITY ACCESS IN NIGERIA [25]



Low access to personal computers and the Internet is another challenge facing the development of IoT and M2M connections in Nigeria. The results of the demand-side RIA Household and Individual ICT Access and Usage Survey for 2012 show that the majority of households in Nigeria continue to be excluded from the full range of communication services. Radio (69.5%) and TV (53%) have the greatest penetration at household level in Nigeria, and fixed telephony (0.3%) and dedicated household Internet (3.4%) are the least-accessed ICT tools [25], as Table 1 shows.

TABLE 1 NIGERIAN HOUSEHOLD ACCESS TO ICT [25]

	Number of households	% of households
Radio	15,270.063	69.5
TV (free-to-air	11,644,796	53
Satellite/cable TV decoder (subscription)	2,834,299	12.9
Desktop PCs and laptops	1,450,107	6.6
Mobile telephone	1,054,623	4.8
Fixed household internet	747,025	3.4
Fixed telephone	65,914	0.3

Digital illiteracy also poses a barrier to the adoption of IoT in Nigeria. In a survey done by Insights Africa on the barriers to Internet usage, lack of knowledge and connection/access were rated as the highest barriers [26]. This illustrates that many people do not use the Internet due to lack of knowledge on Internet use, rather than the cost of it. The high rate of poverty is another limiting factor. Despite the fact that the Nigerian economy is growing, paradoxically, the proportion of Nigerians living in poverty is increasing every year [27].

Future challenges that Nigeria and its industry players will have to address is supplying the technical capacity and people expertise to meet the future boom in the IoT-enabled market. Expertise will be needed in the areas of data mining, big data analytics, wireless sensor connectivity and cloud computing, among others. There will also be new challenges for policy and regulation to contend with.

CONCLUSION: OPPORTUNITIES IN VARIOUS SECTORS OF THE NIGERIAN ECONOMY

Nigeria is presented with challenges in many sectors of the economy, with respect to which IoT can go a long way to alleviate specific problems. Table 2 below is a brief overview of a few topical areas in specific sectors and how IoT can help improve economic performance and social wellbeing.

TABLE 2: PROFFERING IOT SOLUTIONS TO PRESSING ISSUES IN VARIOUS SECTORS OF NIGERIAN ECONOMY

S/N	SECTOR	AREAS OF APPLICATION	STATISTICS/ISSUES OF ATTENTION (ALL IN NIGERIA)	BENEFITS OF IMPLEMENTATION
1	Healthcare	Crowd control + Critical patient monitoring + Tracking of drugs and medical equipment	At least 16 persons lost their lives due to a stampede and many were injured at the Nigerian immigration recruitment exercise in 2014 [28]	Avoidance of death and injury caused by stampede and suffocation in crowded environment. Effective emergency response through best route received from real-time traffic data
2	Transport	Accident avoidance + Traffic monitoring	Between 2006 and 2013 the FRSC recorded 41,118 deaths from road accidents, of which 2,061 in 2013 (74% of accidents resulted in fatalities) [29]	Vehicles provide road safety by monitoring and sensing each other. Monitoring traffic jams through cell phones of the users and deployment of intelligent transport systems (ITS) will help to reduce traffic jams.
3	Oil Industry	Pipeline monitoring	FG and oil companies operating in the Niger-Delta region lost USD14 billion dollars to pipeline vandalism in the year 2014 [30] 51,500 hectares of land devastated by spills in 2014 [30] In 2015, Nigeria's total electricity generation dropped from about 4500MW to 2800 MW due to pipeline vandalism [31] About 60,000 barrels of crude oil and condensate per day are lost through petroleum pipeline vandalism and sabotage [32]	Fight against vandalism, oil spillage and oil bunkering and tracking of vessels and equipment.
4	Security	Military intelligence + Surveillance	Nigeria ranked 4th in the Global Terrorism Index with 303 terrorism incidents, 1,826 fatalities and 457 injuries. Cost of the insurgency to the national economy was estimated at USD28.48 billion [33] 73.3% of business has partially closed operations in northern Nigeria because of this insecurity [34].	Drones with a connected camera and a large wide range can send thousands of images of a dangerous field.
5	Energy and Utilities	Smart metering + Automatic reservoir systems	Electricity supply at 4,306MW, far below the estimated demand of 12,800MW [24]. Only 40 percent of the population have access to electricity [24]. Nigeria is losing about N65 billion annually to electricity wastages due to lapses in distribution and consumers' nonchalance [35].	Reduction of wastage of energy through smart metering.
6	Agriculture/ Environment	Product marketing + Wildlife conservation + Nomadic herding	48 species of animals in Nigeria are endangered; 16 species categorised as rare; 30 species as vulnerable [36].	Fulani or Maasai herdsmen can track the movement of their cattle in real time and get the best grazing advice from weather apps. Avoidance of conflict between nomadic communities at meeting points. Precision agriculture helps farmers maximise resources like water, increase yield and market their produce directly to consumers. Accurate identification of animals aids disease control.
7	Waste management	Recycling + Waste disposal	Most cities spend 20-50% of their annual budget on solid waste management and only 20-80% of the waste is collected [37].	Monitoring of vehicle emissions to help supervision of air quality, the collection of recyclable materials and the reuse of packaging resources and electronic parts to avoid waste.

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MOBILE PHONE TECHNOLOGY AND READING BEHAVIOUR: COMMENTARY ON THE FunDza PROGRAMME

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KEYWORDS
mobile phones, self-initiated reading, enjoyment, gender, reading literacy, reading preferences, motivation

South African learners generally perform badly on external tests of reading literacy. In the 2011 international Progress in International Reading Literacy Study (PIRLS), South African Grade 4 learners performed poorly in comparison with their international counterparts, especially on higher order comprehension (Howie, van Staden, Tshele, Dowse, & Zimmerman, 2012). The 2013 Annual National Assessments reported a national average percentage of 43% for Grade 9 learners in their home language and 35% in a first additional language, which often is English (Department of Basic Education, 2013). The Department's report recommended that learners be encouraged to read additional books, and more widely, to improve their scholastic attainment. There is much evidence to support the argument that reading for pleasure has a positive effect on both personal and educational development (e.g. Clark, 2011). Encouraging learners to engage in self-initiated reading as a leisure activity therefore may be positively related to reading literacy. Unfortunately, many South African learners attend schools with no libraries, and come from households without resources, including books, to promote reading (Howie et al., 2012).

The question then is how to fill this gap, to provide reading content to young people who are interested in reading, but who find it difficult to access reading material that would interest them. For a number of years now, mobile phone technology has been seen increasingly as a promising platform to deliver educational services, including literacy development (Lee & Wu, 2012). UNESCO, for example, organises mobile learning weeks. At the second such week, it specifically addressed the question of mobile technology and literacy development for young people and adults (UNESCO, 2013).

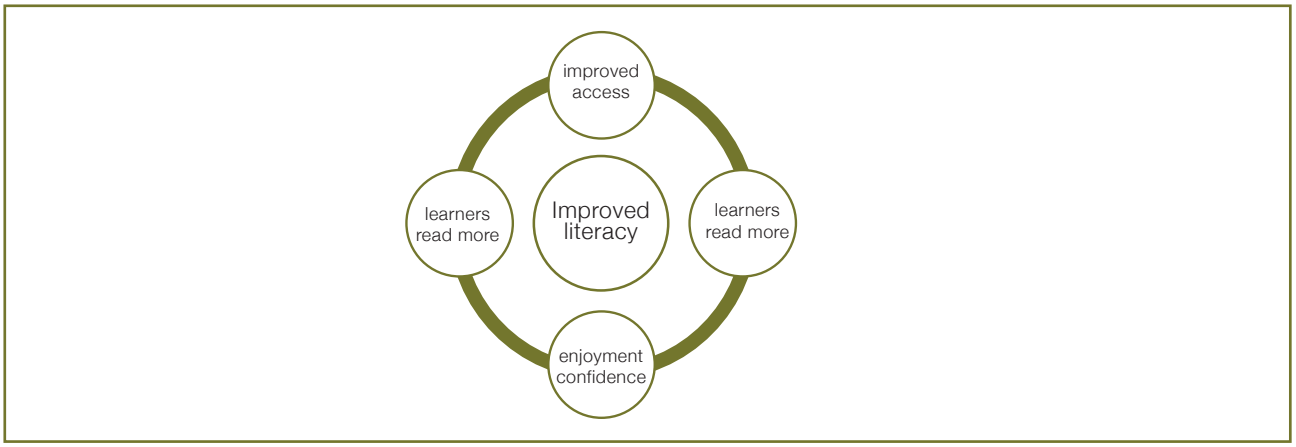
In South Africa at least two non-profit organisations have developed projects to deliver reading materials to young people via this medium. One is the m4Lit project, funded by the Shuttleworth Foundation, which gives young readers access to novels via the mobile phone. Vosloo (2010) found that these novels attracted over 60,000 reads, suggesting that mobile phone-based reading is a viable strategy to encourage reading.

Our researchers have been working with the second organisation, the FunDza Literacy Trust, to provide an assessment of the viability of mobile phones to attract readers. The Trust has been in existence since 2011 and provides readers with locally-written material in a number of South African languages through the mobile social application Mxit or FunDza's website, http://www.FunDza.co.za This research note offers an overview of work on FunDza reported in three, separate, scholarly publications.

The goal of the programme is to improve reading literacy among teen-aged and young adults in low-resource communities. It regards a major cause of low literacy rates in these communities as being insufficient access to appropriate reading material. Thus FunDza, in its programme named the Growing Communities of Readers Programme (GCRP), makes reading material available through their mobi site and Mxit portal.

The expectation is that reading the books supplied via this channel would increase interest in reading, enjoyment of reading and confidence in own reading ability. An increase in these variables, in turn, ought to reinforce and strengthen reading: young people will read more (in terms of numbers of books, length of time, and frequency), and differently (what they read). This virtuous cycle is presented in Figure 1.

FIGURE 1: LINKS BETWEEN ACCESS TO READING MATERIAL, ENJOYMENT, AND READING LITERACY



The ultimate question is whether interventions like these will result in increased reading literacy levels, though to answer it would require a complex, large-scale study. Mobile technology has a feature that would enable us to examine specific aspects in this improved literacy cycle: it automatically captures a huge amount of data on reading behaviour in the form of computer log files. We used this database, coupled with brief surveys distributed to readers, to conduct three studies in partnership with FunDza to address such questions (De Villiers, Louw, & Tredoux, 2015; Horley, 2014; Tredoux, Louw, & Louw-Potgieter, 2015). The results are summarised below.

DOES THE PROGRAMME ATTRACT SIGNIFICANT LEVELS OF PARTICIPATION?

To be regarded as successful, a programme such as FunDza's GCRP must at least attract readers and get them to read the material provided. A large number of readers (65,533) used the site over a nine-month period in 2013, where 59% belonged to the programme for at least three months and 43% belonged for more than six months (Tredoux et al., 2015). In the De Villiers et al. study (2015), 40,886 readers between the ages of 13 and 19 years visited the FunDza reading site within a six-month period in 2014.

HOW MUCH DO THEY READ?

Tredoux et al. (2015) found that FunDza users read at least 65 characters during the visit. More than half of them read quite a lot more: about 33,000 readers clicked on the equivalent of 75 A4 pages of reading material. The log files showed that 50% of users visited the site seven times or more. The top 25% of readers, in terms of accessing the site, visited FunDza 39 times or more.

WHO ARE THE READERS?

The majority (2,857 out of 3,521) of respondents in the Tredoux et al. study (2015) had a mean age of 19.7 years. Thus the programme seems to attract mostly young people, as intended. Their answers to the questions in the brief survey indicated that they already enjoyed reading, but did not have access to physical books to read (i.e., they are "book-poor"). Thus one could say that the programme gives young people who want to read, access to reading material that they don't have, which is an important objective of FunDza. It is, however, not possible from this data to say whether the programme attracts new readers and turns them into enthusiastic readers.

Males accessed the material less frequently than females. Hardie (personal communication, 29 April 2014) estimated that approximately 75% of the database are female. Our studies support this observation: in Horley's (2014) study, 76.9% (n=908) of the sample were female, and De Villiers et al. (2015) found that 28,450 of their 40,886 users were female.

WHAT IS THEIR MOTIVATION FOR READING?

Motivation for reading is important in areas of learning and literacy, although local research on this topic is hard to find. Horley (2014) took a cautious first step in this regard. She distributed a brief questionnaire via young readers' mobile phones, based on Wigfield and Guthrie's (1996) Motivations for Reading Questionnaire. Data from 1,014 respondents revealed that girls were much more motivated to read than boys, and read for different reasons. They also read almost three times more material than boys, which fits the general pattern that males to read less than females (Logan & Johnston, 2009). Similarly, Machet (2002) surveyed school children in Gauteng and established that, overall, boys read significantly less than girls. Furthermore, in Horley's study, boys tended to read for extrinsic reasons: they wanted to compete with their peers; to receive a reward in acknowledgment of reading achievement; or to get good grades in school. Girls read more if they had positive perceptions of their own reading ability, or ability to progress in their studies – what is referred to as self-efficacy beliefs in the literature.

De Villiers et al. (2015) investigated gender differences in reading preferences by distributing a questionnaire to a sample of readers, as well as examining the actual stories read on the site (via the log files). The responses to the questionnaire did not differ much from the picture that emerged from the visits to the website. In both male and female data sets, romance was the genre that got the highest percentage of "really like" ratings, followed by drama, non-fiction, and stories with a specific South African content. A higher percentage of males also preferred stories involving sport. These preferences are somewhat unexpected in terms of the existing literature that males would like the genres of drama and romance to this extent, both in terms of their self-reports and their actual reading behaviour.

DOES PARTICIPATING IN THE FunDza GCRP CHANGE READING BEHAVIOUR?

This is the most difficult question to answer, and one that we could address only in an indirect way. An approach to a question like this is to look for "dosage-response" relationships; i.e., the more of a programme a participant receives, the stronger the effect would be. Tredoux et al. (2015) took as a dosage measure the number of pages that participants read, and related a number of key variables to this metric. They generally found that the more participants read, the more likely they were to indicate that they enjoyed reading outside of school, that they considered themselves good readers, that they read for longer, and that they read more outside of school in the most recent month. More importantly, hierarchical linear multiple regression analyses showed that a higher dosage (i.e., more pages read) was associated with increased enjoyment of reading, proficiency in reading, amount of reading and book reading (all based on self-ratings).

CONCLUSION

A particular strength of the present analysis is that it relies to a large extent on actual reading behaviour, and not just on self-reports. Based on an analysis of the log files on the FunDza database, and brief questionnaires distributed to readers, the following conclusions from the three studies are justified:

- The delivery of reading material via the FunDza mobi site and mobile phones appeals to sufficiently large numbers of young people, the majority of whom actually read an impressive amount of the material provided to them. Thus it is fair to conclude that the programme is improving access to reading material to young people in "book-poor" environments.
- There is a distinct gender bias in participation in the programme and in reading behaviour; in each case, females tend to outdo males. There were some interesting differences between males and females in motivation to read and in reading preferences.
- We are reasonably confident that participating in the GCRP has a positive influence on a number of reading behaviours, as reported by readers.

These conclusions support the virtuous cycle in Figure 1, where access to reading material is linked to enjoyment of reading and confidence in reading performance and in turn linked to reading literacy. This virtuous cycle depicts what happens to girls when they have access to reading material via mobile phones. The challenge remains to draw more boys into this cycle.

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CASE NOTES: FACTORS INFLUENCING THE ADOPTION OF VIRTUAL DESKTOP INFRASTRUCTURE (VDI) WITHIN THE SOUTH AFRICAN BANKING SECTOR

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ABSTRACT
In the 21st century, portable computers and wide area networks are fast becoming the paradigm for computing presence in commercial and industrial settings. The concept of virtualisation in computing originated in the 1960s. Several virtualisation technologies have emerged over the past decade, with the most notable being VMWare, Citrix and Microsoft VDI solutions, including Azure RemoteApp. This paper explores factors influencing the adoption of VDI in the South African banking sector by implementing Rogers' "perceived characteristics of innovations". The study found that the relative advantage of VDI, as perceived in banking institutions, includes improved data security and staff working experience; reduced time to deploy devices; and reduced computer downtime. The findings on compatibility factors indicate that good VDI compatibility with legacy software and hardware has a direct relationship with users' successful adoption. The findings on complexity of use show that other factors, such as the flexibility that comes with remote access, may be a greater influence on adoption than ease of use. Observability of reduced IT support time and increased productivity of remote access have a positive relationship with adoption.

KEYWORDS
virtual desktop infrastructure, VDI, virtualisation, thin client, innovation in banking, perceived characteristics of innovations

INFORMATION TECHNOLOGY IN BANKING: RESEARCH PROBLEM AND OBJECTIVES

The South African banking sector had total assets of approximately ZAR4.6 trillion in September 2015, of which ZAR3.5 trillion consisted of gross loans and advances, ZAR885 billion consisted of home loan assets, ZAR325 billion consisted of commercial mortgage assets, and ZAR108 billion consisted of credit card assets (SA Reserve Bank, 2015). The banking sector allocates a sizeable portion of its annual capital and operating budgets to information technology purchases and deployments (Wati & Koo, 2009). Accompanying the focus on funding is an increasing drive for improved productivity and better use of new and existing IT assets. Traditionally, personal computers have comprised one of the pillars of computing in the banking sector. The complexity of personal computers (PCs) is one of the reasons for the high cost of IT (Valovic, 2009). Vast financial resources are required to maintain and optimise activities such as software licensing, data security, business continuity and upgrading of computer hardware and general technology infrastructure to meet new organisational requirements, resulting in the ever-increasing costs of managing their life cycle. Furthermore, the PC environment has particular shortcomings, including the challenges associated with asset and configuration management, hardware and software management, installing and patching operating systems and applications, and creating higher levels of data security.

One innovative approach to meeting these new organisational requirements is to make use of virtual desktop infrastructure (VDI) to extend computer life, reduce IT costs, improve security and increase availability of technology (Miller & Pegah, 2007). The improvement in productivity reported by companies that have adopted VDI suggests that the introduction of this technology into the banking sector may result in the attainment of similar benefits (Gartner, 2011), however, evidence is required. Gartner trends research also indicates that virtualisation using thin clients will lower IT capital expenditure, when computing becomes just an operational expenditure, because thin clients are less than half the cost of a traditional PC and have a longer life cycle. This is referred to as a "shift from capital to operating expense" (Gartner, 2011).

This article reports on a 2014-2015 study that explored the factors affecting VDI adoption and its impact in the South African banking sector, in terms of reducing cost, increasing manageability of patching, remote access, improved data security and recovery, better compliance and reduced energy consumption.

TRANSITIONING FROM PERSONAL COMPUTERS TO VIRTUALISATION OF DESKTOP INFRASTRUCTURE (VDI)

Desktop computers or PCs (including laptop and tablet devices) offer an environment of inadequate options for contemporary computing use, including limited hard drive storage, longer provisioning time, distributed IT support staff, a short refresh cycle, and leave an environmental footprint during and after production (Infosys Technologies, 2011). In a context where the gap between available resources and the demand for IT resources is widening, IT departments are expected to do more with less, and desktop virtualisation has become a viable option for server consolidation and has produced tangible cost savings (Miller & Pegah, 2007). Desktop virtualisation entails a strategy whereby the operating system and applications are moved from the personal computer (thick client) to a server. The computer screen still displays the image of the desktop, but in reality it is just a shell (Löfman, 2011). The client represents the graphical user interface (GUI) and the communication with the server that is hosting the desktop, while the applications and actual processing are done on the server.

1 In each publication, the journal may select one Masters level contribution for inclusion.

BENEFITS AND CHALLENGES

By virtualising the PC (creating a thin client), management costs for desktops decrease, as applications are no longer installed on individual PCs (Beaty, Kochut & Shaikh, 2009). All updates are performed in data centres, hence the management costs decrease while the manageability of desktop infrastructure improves. This centralised updating is called patch management. The IT department is assured that every user has the correct patch and version of the software, as the patches are installed on the server. As no confidential material is stored on the thin client, the security can be increased with ease, and the information/data is safely locked away in the server. This does not protect the company if a malicious user gains access to the thin client and can log into the servers. Thus users remain responsible for not giving away access and authorisation rights. (Löfman, 2011).

As most of the IT support functions are moved to a data centre, on-site labour costs in terms of helpdesk functions and on-site IT support staff decrease, though there is a shared cost to virtualisation. As a result, virtual desktop infrastructure should have lower total cost of ownership (TCO) than a traditional PC infrastructure (Beaty, Kochut & Shaikh, 2009).

Older computers can continue to be used, obviating the need for upgrades, since the performance is solely dependent on their ability to establish a network connection (Löfman, 2011).

VDI also provides excellent business continuity, as "desktops" are available anytime, anywhere. Employees can easily work at a remote location or from home, which provides the kind of flexibility that is important for organisations that operate in increasingly difficult economic conditions. The ability to provide or relocate a desktop through VDI opens up new opportunities for businesses (Sarrel, 2010).

TRIGGERS OF VDI ADOPTION IN THE SOUTH AFRICAN BANKING SECTOR

PC management is becoming increasingly difficult for banks, partly due to the escalating costs of managing the hardware life cycle. In addition, data security and software compliance are of paramount importance in the context of the cyber-security risks pertinent to financial transactions. An increasingly mobile workforce adds another layer of complexity to ensuring that end users can easily connect wherever they are, in addition to ensuring that data stored on the PC is secure when it leaves company premises (TBR, 2008).

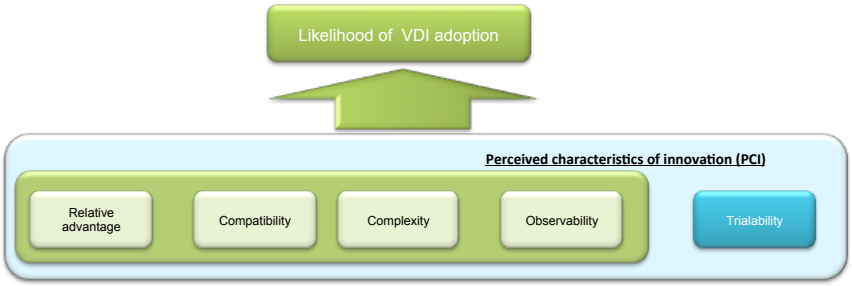
Typically in a desktop environment, IT staff need to access computers, either directly or remotely, in order to fix problems. Software applications regularly require updates and patches in order to protect them from external vulnerabilities. In many cases, these are automated and occur frequently during non-work hours when users' PCs are turned off. Users often disregard instructions and do not install updates or patches, resulting in PCs becoming noncompliant and vulnerable to infection with malicious software (VMware, 2008). Increasingly, users are downloading and installing personal software, thereby adding to the problem of desktop vulnerability.

In summary, an objective of any good business, including those in the banking industry, is to attain the lowest total cost of ownership (TCO). Banks and other firms quantify and measure the various associated costs for the purpose of planning future budgets, and for improving efficiencies and effectiveness in business processes and levels of service (Lam, 2010).

RESEARCH FRAMEWORK: PERCEIVED CHARACTERISTICS OF INNOVATION APPLIED TO VDI IN BANKING

The researcher adopted the perceived characteristics of innovation stated in Rogers' diffusion of innovations theory (Rogers, 2003) to guide the structure of the interview, as well as the observation indicator rating scale. Perceived characteristics of innovation were adopted to explain how and why technology is adopted rapidly. Research relating to customer adoption of innovations, especially in the information technology field, has tended to concentrate on identifying the characteristics of innovators and early adopters (Black, Lockett, Winklhofer, & Ennew, 2001). Although such characteristics of innovators have been identified as significant determinants of consumer's adoption of an innovation, some researchers have argued that the perceived characteristics of the innovation are stronger predictors of the adoption decision than characteristics of the innovators themselves (LaBay & Kinnear, 1981), see research guiding framework in Figure 1 below.

FIGURE 1: VDI RESEARCH FRAMEWORK



Source: Adapted from Rogers, 2003 (Perceived characteristics of innovation)

RESEARCH QUESTIONS AND METHODOLOGY

The main research question was framed as: What factors influence the adoption of virtual desktop infrastructure (VDI) within the banking sector in South Africa?
The secondary questions were framed as follows with respect to South Africa:

- What relative advantages does adopting VDI have in the banking sector?
- How compatible is VDI with banking legacy systems and applications?
- How easy or complex is it to use VDI in the banks?
- How observable are the benefits of VDI in the banking sector?

The research used a single institutional case study approach, collecting qualitative data through interviews and observation of IT staff who were either using VDI or had experience in the use of VDI, within a single large banking institution in business for many decades. The rationale for using a case study approach was to elicit data on experiences with regard to the adoption of VDI technology. At present, limited academic studies are available that explore factors for VDI adoption and its impact within the banking sector in South Africa. The importance of this exploratory study is its examination of the opportunities for leveraging benefits from replacing the thick client PC with virtual desktop infrastructure. The research results provide initial evidence relevant to banks and banking sector professionals who wish to understand the virtual desktop adoption factors in their industry and who are considering adopting VDI technologies.

The perceived characteristics of innovation by Rogers (2003) were adjusted to formulate specific interview questions for the VDI in banking study. Seventeen broad questions were framed, divided into four categories, which represent the perceived characteristics of VDI adoption, namely relative advantage, compatibility, complexity, and observability. Data was gathered via multiple means, including interviews, observations and a review of the case study bank's reports on incidents and service requests (for 2013 and 2014), as a means of data triangulation, in order to enhance the reliability of the findings. However, general data from the bank report is not permitted to be used for publication.

For interviews, the units of analysis were the bank's IT personnel who use or support VDI. The interviews were focused on eliciting the subjective experience of the respondents who were working with VDI, either as a user or in a project team or in a business-as-usual (BAU) support team, within the IT business units of the case study bank. The seven respondents comprised IT network managers, business analysts, IT technicians and VDI users. The data from interviews is reported here.

The research findings were analysed and responses were categorised based on the codes assigned to the secondary research questions. Feedback from each participant was evaluated and compared with similar responses in the same category for a specific *a priori* theme. Similarities, dissimilarities and new themes emerging from the responses were gauged. The results were viewed holistically, as the aim was to find common factors, or evidence to support the nature of specific inter-relationships (or lack thereof).

The study had a number of limitations. Firstly, only one bank participated in the study, though requests were made to a number of South African registered banks. Secondly, a limited number of interviews (seven) were conducted with IT personnel at this one bank. Hence, this study was effectively an exploratory study. Data from respondents was very basic as interviewees gave the same or similar responses to certain interview questions, even though their job roles were different. A deeper understanding of the subject requires a larger number of participants and participation from multiple banks. Therefore, the results of this study cannot be generalised to the entire population of banks in South Africa. However, it does give some indication of the importance of this area of research.

DOCUMENT REVIEW AND INTERVIEW FINDINGS: FOUR PERCEIVED CHARACTERISTICS OF VDI ADOPTION

Drawing on the case study bank's incidents and service request reports, the findings were that new non-mobile users (joiners) to the banks were issued with VDIs and very few fault reports were logged for VDI, noticeably mainly where users were requesting password resets.

Findings from interviews and observations are set out below noting key characteristics pertaining to VDI use, reporting user and manager statements, and providing a summary figure. Each graph illustrates one of the four categories of factors influencing VDI adoption, namely relative advantage, compatibility, complexity/ease-of-use and observability.

RELATIVE ADVANTAGE OF VDI

With respect to relative advantage, about 58% of participants agreed that VDI has improved their day-to-day work experience, indicating greater advantage compared with desktops, noting various characteristics, see Figure 2 below. The findings reveal that (i) VDI technology has drastically reduced computer downtime, evident in the following statement:

> I agree in terms of software upgrades, it doesn't have a direct impact on the device. I don't have to stare at the machine while it finishes installing some software; be it antivirus or just a patch.

(ii) VDI is seen to have improved data security as compared with personal computers (70% of respondents agree), explained as follows by two respondents:

> There is better data security as this is a centralised system

> If I lose my personal computer there is no risk of data being lost too as it is stored outside my personal computer, with the use of VDI.

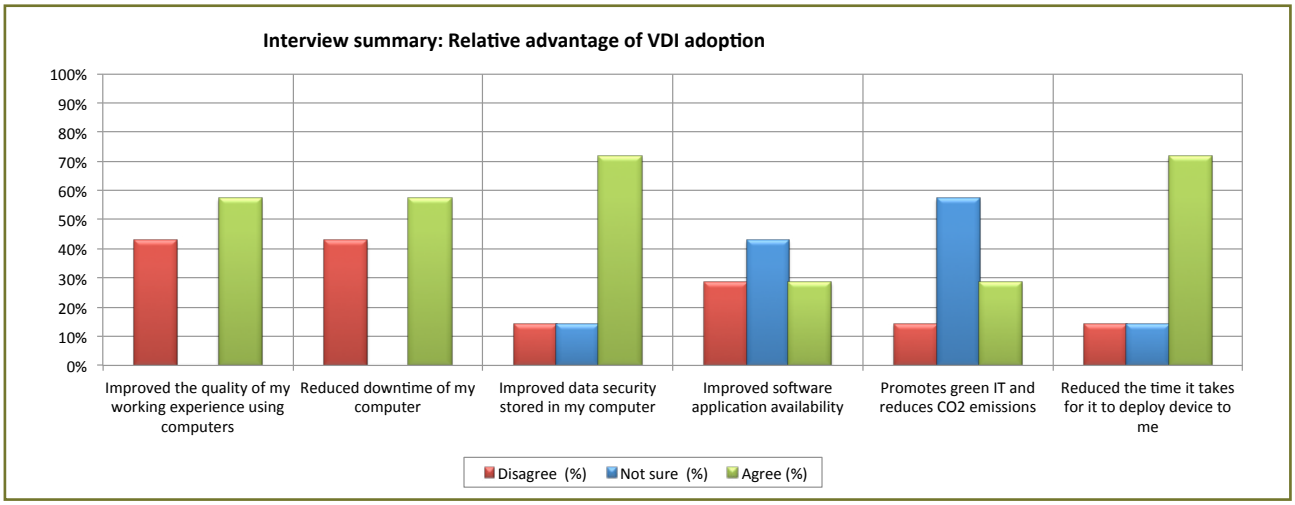
However, (iii) about 42% of respondents were not sure whether VDI has improved application availability:

> I am not sure, I have not noticed any difference compared to my old desktop.

> Availability between the two technologies is the same, in my opinion.

Uncertainties were also noticeable with respect to the question of whether VDI reduces CO2 emissions, as 68% of respondents were not sure about the benefits. Notably, 71% of respondents agreed that it now takes less time for the IT department to deploy VDI devices as compared with desktops or laptops.

FIGURE 2: SUMMARY: PERCEPTIONS OF RELATIVE ADVANTAGE OF VDI ADOPTION



COMPATIBILITY OF VDI WITH LEGACY SYSTEMS

It has been argued that the compatibility of new technology to the individual's job functions will influence the adoption of the new service (Tornatzky & Klein, 1982). In this particular case, users are more likely to adopt VDI if it is compatible with legacy systems and applications used to perform their daily tasks. With respect to VDI compatibility with existing technologies in the banking workplace, 85% of respondents agreed that VDI functions well with the applications used to perform day-to-day functions. About 71% attested to VDI being compatible with legacy software and hardware applications. In addition, 86% of participants said they have good experiences when accessing VDI sessions remotely. This data is illustrated in Figure 4 below.

Respondents indicated that they experience challenges with VDI with respect to some applications:

> VDI is mostly slow with large Visio documents and (the) PtoH legacy application I use … day to day.

> Not sure if it was just IE6 vs. IE7 issue on windows 7 for AOR users, it was a bit of a hiccup, had to downgrade due to incompatibility.

As illustrated in Figure 4 below, 85% of participants agreed that VDI works well with applications which participants need to do their day-to-day work:

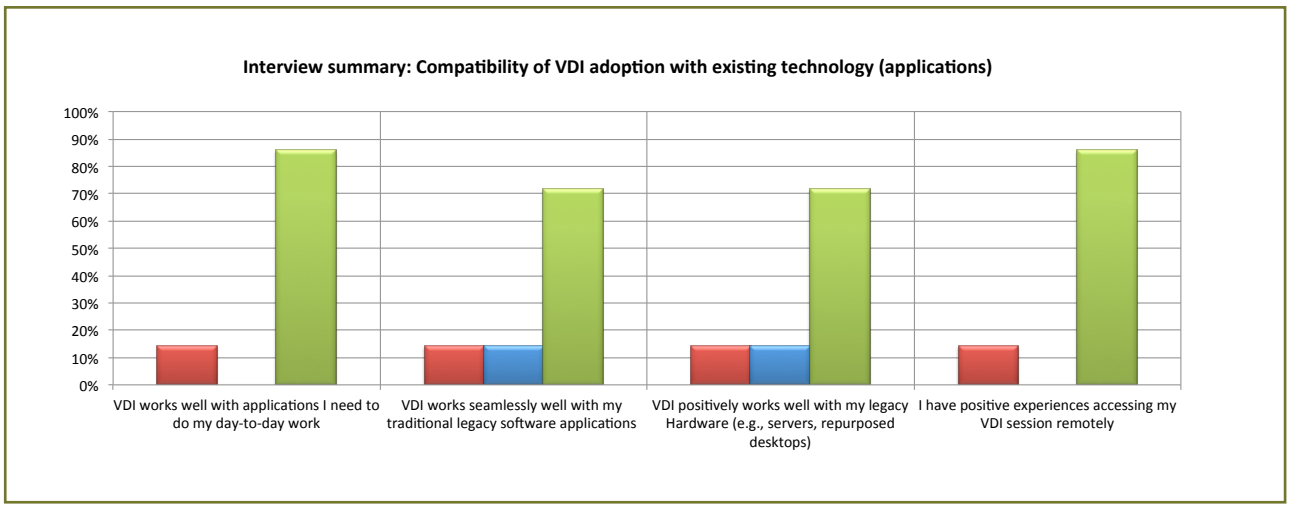
> I use standard applications (MS Office and SAP) so I haven't experienced any problems.

> All my apps were fully functional.

> I mostly use Microsoft apps on day-to-day and I haven't experienced any issues using these apps.

> All the office apps that I rely on were readily available.

FIGURE 3: SUMMARY: COMPATIBILITY OF VDI ADOPTION WITH EXISTING TECHNOLOGY (APPLICATIONS)



EASE OF USING VDI

In terms of ease of VDI use (see Figure 6 below), all participants (100%) agreed that it is easy and requires less complex procedures to use than the thick client PC:

> In my experience of using the VDI, it was a pleasant experience in my day-to-day (work).

With regard to the extent to which VDI simplicity would affect respondents' decision to adopt VDI, respondents were of the opinion that there are other factors that they would take into consideration when considering adopting any technology.

> I don't adopt a technology due to only its simplicity, there are other factors as well … portability, battery life.

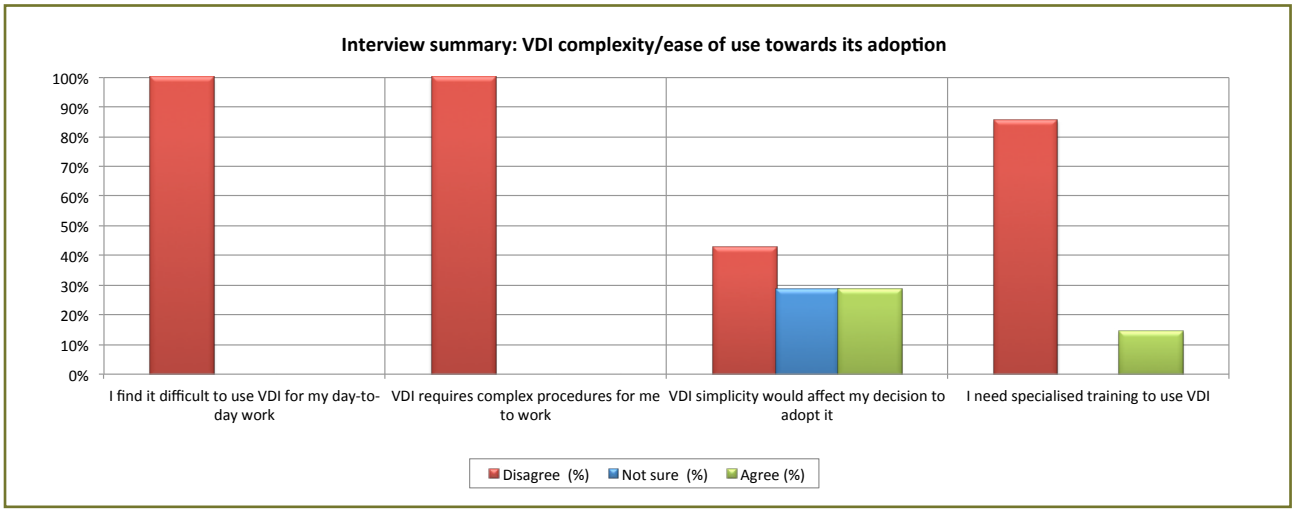
40% of respondents disagreed with the statement that VDI simplicity would affect their decision to adopt, citing reasons that:

> This is (a) perception based question – a lot goes into deciding to adopt any technology. (In this particular instance, remote access was considered more important than simplicity.)

> I would be happier if I no longer have to carry a laptop.

83% agree that staff do not need any form of specialised training to use VDI.

FIGURE 4: SUMMARY: VDI COMPLEXITY OR EASE OF USE



OBSERVABILITY OF VDI ADVANTAGES

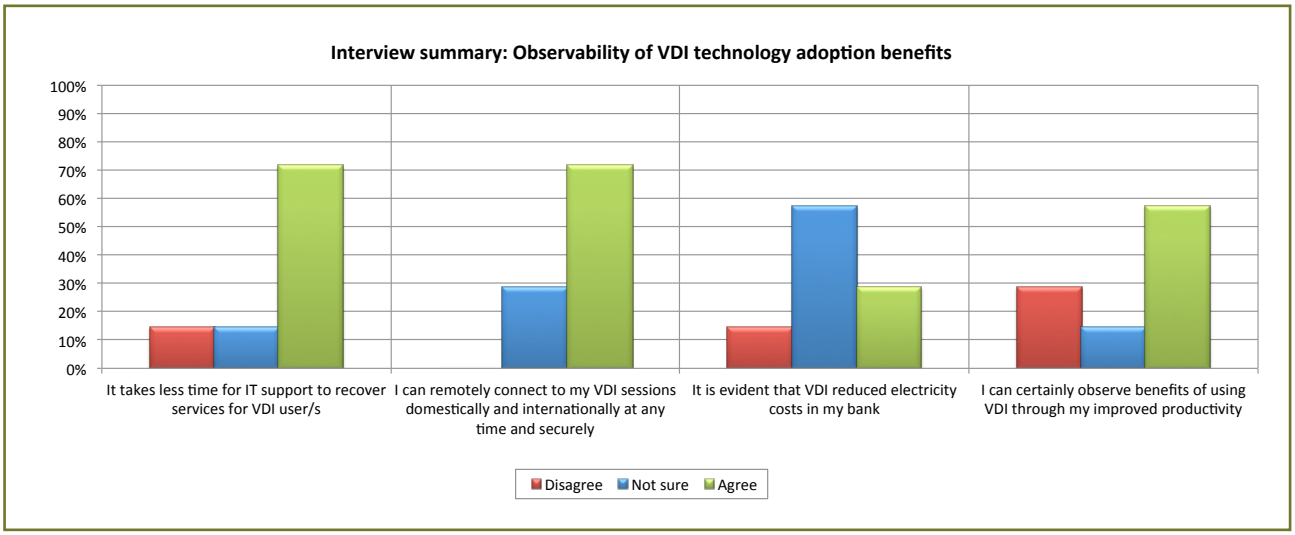
The respondents agreed that VDI benefits are observable. Just more than 70% agreed that it takes less time to recover data compared with working with desktops, mainly due to the fact that data is stored in a remote server farm, which makes it easy for the IT storage team to retrieve, see Figure 8 below. As illustrated in Figure 8, 70% of participants indicated that they can remotely connect to their VDI sessions domestically and internationally at any time and securely. Sample, verbatim responses regarding the observability of VDI benefits are:

> Agree, although speed would likely become an issue when connecting internationally.
>
> Agree, I travel between our regional offices and indeed I can work remotely any day at any time.
>
> Domestically, yes I agree this worked well."

Although 60% of participants are not sure if VDI reduces the cost of electricity use, 58% of respondents say they can certainly observe the benefits of improved productivity through using VDI:

> Agree, the flexibility of being able to work from anywhere definitely has resulted in improved productivity.
>
> On the other hand, respondents maintain that recovery services for VDI users are not more time efficient than desktop support. In both cases, the service level agreement is a minimum of three days.
>
> Agree, normally yes, but this is based on a minimum 3 days SLA for data recovery.

FIGURE 5: SUMMARY: OBSERVABILITY OF VDI TECHNOLOGY ADOPTION BENEFITS



ANALYSIS OF FINDINGS: KEY THEMES THAT EMERGE FROM THE DATA

In this section, we briefly examine the influence on adoption with respect to the four perceived characteristics, offering four *a priori* themes.

A PRIORI THEME (1): RELATIVE ADVANTAGE OF VDI IN INCREASED DATA SECURITY AND REDUCED TIME FOR DEPLOYMENT STRONGLY INFLUENCES ADOPTION

The study found that, with respect to relative advantage, the characteristics of improved data security and reduced time for deployment of devices scored the highest ratings, followed by the characteristics of staff working experience, reduced computer downtime, and green IT. The software application availability included in the relative advantage construct is the only attribute not supported out of the five innovation attributes used for this construct. Findings show that application availability has a negative relationship with adoption, as respondents did not regard application availability as an advantage gained from VDI.

A PRIORI THEME (2): VDI IS COMPATIBLE WITH LEGACY SOFTWARE AND HARDWARE STRONGLY AFFECTING ADOPTION

The compatibility characteristics that significantly support adoption of VDI in banks includes how well VDI works with day-to-day applications, compatibility with legacy software and hardware and remote use experiences. Such compatibility positively influences adoption. It is important to note that in theory, vendors offer compatibility of their VDI technology with a competitor's server virtualisation technology. For example, it is possible to run a Citrix XenDesktop VDI system on a virtualised data centre powered by VMWare's vSphere virtualisation software (Shad, 2011).

A PRIORI THEME (3): VDI EASE OF USE IS A WEAKER INFLUENCE ON ITS ADOPTION

The research results on complexity or ease of use indicates that users' experience in using VDI and the ease of use of this technology may not be the strongest influence on the adoption and that considerations such as the value gained from remote access are more important to the user or IT manager than ease of use. In other words, users and IT managers will tolerate complexity of use in favour of remote access.

A PRIORI THEME (4): VDI REDUCED IT SUPPORT TIME, REMOTE ACCESS AND REDUCED ELECTRICITY COSTS STRONGLY INFLUENCES ADOPTION

The observability of reduced IT support time, remote access and reduced electricity costs may encourage VDI adoption, particularly among IT and business managers responsible for very large IT budgets and ancillary costs.

IMPLICATIONS FOR RESEARCH

The findings from this study have significant implications for the banking research community. Overall, the results of this exploratory study show that bank VDI technology adoption is influenced by each of the perceived characteristics of innovation in Rogers' (2003) framework. Further research could expand the study to all South African banks, designed from a combined industry and academic perspective, enabling banking institutions to participate in studies that examine a range of innovation characteristics, rather than only examining the medium-term financial and operational benefits.

IMPLICATIONS FOR SOUTH AFRICAN BANKS

The findings from this study have important implications for banks that use VDI or are intending to adopt such technology. The study revealed that the relative advantage of such technology, its compatibility with organisational values, its ease of use and observable benefits were among the most significant factors encouraging VDI adoption. This suggests that it is essential for banks to investigate the benefits of using VDI and to publish milestones or perceived benefits, for example electricity consumption statistics before and after implementation of VDI technology.

CONCLUSIONS

VDI was perceived to have a relative advantage over thick client PCs in a single large banking institution – this should come as no surprise. What is of interest, however, is the set of factors to be considered with respect to advancing VDI adoption. Banks that continue with or are planning to adopt VDI are likely to benefit from its compatibility with many legacy systems, and staff require no additional computer skills as it consists of the same features as the desktop. While some of the benefits are visible to the organisation, better organisational communication of the benefits of VDI is needed.

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BOOK REVIEW: NAGY HANNA AND RENE SUMMER'S INSIGHTS INTO A HOLISTIC ICT DRIVEN TRANSFORMATION

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Hanna, N. K. & Summer, R. (2015). *Transforming to a networked society: Guide for policy makers*, Gaithersburg: Sriban Books.

INTRODUCTION

This contribution presents a review of the book "Transforming to a Networked Society: A Guide For Policymakers" by Nagy Hanna and Rene Summer. The book offers an in-depth analysis of how information and communications technologies (ICT) applications and networks can be leveraged to harness human capital and generate value for business and society. It presents an analysis of what it will take for any emerging economy to leverage the ICT technological revolution and transform itself into a smart economy. From the viewpoint of a policymaker engaged in Kenya's ICT boom, the authors' systematic approach makes the reading pleasurable and informative, even for someone unfamiliar with the growing body of knowledge on the transformative nature of ICTs. It would be particularly helpful to policymakers, especially those in developing countries seeking to transform their economies, to practitioners seeking to understand the process of transformation and to researchers seeking a holistic understanding of the ICT sector and the digital economy.

KEYWORDS

book review, ICT transformation, digital transformation, networked society

OVERVIEW OF THE BOOK

Transforming to a Networked Society marks a pioneering account of a holistic ICT-enabled transformation in a single volume. Nagy Hanna and Rene Summer created a policymaker's manual to harnessing the potential of the smart economy and transformative networks. To the reviewer, having always assumed that digital transformation can only be explained in compartments of communications infrastructure, digitisation, skills, mobile technologies and policy frameworks, Hanna and Summer provide a refreshing account of how all these compartments work together to transform economies. For example, in an analysis of the ICT ecosystem, they suggest that policymakers invest in enablers of ICT transformation such as ICT education; ICT services development; policy reforms and institutional changes; ICT-led business process innovation; new business and organisational models; and e-leadership capabilities.

The authors bring a combined wealth of experience into this seminal work for the ICT sector. Hanna, a doctoral graduate of Wharton School, brings to this work more than 40 years of teaching experience, writing, and working with the World Bank as senior advisor to dozens of countries on the implementation of ICT strategies. And Summer's many years at Ericsson Group, with global responsibility for national ICT strategy, particularly media/content regulation, copyright, media convergence and data protection, enrich the specificity of the content.

The book, written in three parts, therefore provides grounded and relevant policy advice for developing countries considering ICT as a transformative set of infrastructures and services.

Part I delves into the big picture of ICTs – why we need ICT-enabled transformation in today's economy and the key strategic components required to get transformation off the ground. Part II reads like a practitioner's guide with its detail on the transformative possibilities of integrating a digital component into business, and key government sectors such as education, health and agriculture. Part III, perhaps the most important section in the book, delves into how to master implementation of ICT, detailing how to develop leadership and institutions, and enable policies and regulations. In addition it looks at communications infrastructure, the industry, and the implementation, monitoring, evaluation, and adaptation needed.

In the following section, I provide a summary description of key chapters and towards the end, a critical analysis of the book.

SUMMARY OF KEY CHAPTERS

For policymakers in developing countries, Part III of the book, themed "Mastering the implementation of digital transformation", potentially offers the most useful insights and for this reason, is the focus of this review. In Chapter 6, the first chapter of Part III, the authors discuss how to create and harness the transformative leadership required to build the institutions to nurture digital transformation. In order to achieve the desired leadership they suggest that governments clearly define their role in creating a networked society and adopting a governance model and institutional framework that draws on the global knowledge derived from country-level experiences. Providing examples and lessons learnt from stakeholder engagement, this section discusses developing legal and regulatory policy, building high-level and/or "executive" function for ICT, managing an effective division of labour across the relevant departments and agencies, securing funding and buy-in, and creating mechanisms for monitoring and evaluation. The authors emphasise the importance of engaging transformational leaders, as well as developing core leadership competencies.

In Chapter 7, the authors probe into how to develop enabling policies and regulations, suggesting that a convergent technology environment calls for coherent, technology-neutral policy and institutional frameworks, political leadership and commitment to a long-term view to secure effective regulation and sustainable transformation. It also argues for the importance of policy frameworks to enable transformation, with specific emphasis on regulatory objectives such as market efficiency; public interest and rights-based regulatory approaches; and networked governance and transformative policy. It also discusses research and development, innovation, diffusion and use, and finally implementation of ICT initiatives.

Chapter 8 focuses on developing the communications infrastructure and draws from the experience of developed countries. It proposes a series of interventions, including formulating broadband plans, assessing existing supply and demand challenges, addressing the challenges associated with spectrum management to enable mobile broadband, setting measurable objectives to improve supply through infrastructure build out, and promoting demand for services and applications. The authors suggest that a clear sense of direction would encourage investment and provide a blueprint for long-term actions. It makes a strong case for why national plans should promote efficiency and equity, support national social and economic goals, strive to attain universal access to and affordable supply of broadband, while also encouraging enabling technologies such as cloud computing. Plans, in their view, should include definitions of broadband, service goals, transmission capacity, service quality, and demand-side measures such as the required education and skills.

Chapter 9 deals with implementing, evaluating, and adopting policy. The authors sum up the lessons in 10 fundamental steps, including committing to a holistic long-term strategy, integrating ICT into development, attending to soft infrastructure and complementary policies, and engaging stakeholders and pursuing partnerships. It also focuses on political leadership; planning; legal framework; public sector oversight, emphasising diffusion and inclusion; balancing strategic direction with local initiatives; and enabling change and adaptation, innovation, learning, monitoring and evaluation.

CRITICAL ANALYSIS

In Part I of the book, Hanna and Summer dedicate two chapters to answering the questions: Why do countries pursue digital transformation? Why is a holistic approach to transformation the most effective? In doing so, they conceptualise new ways of thinking about the roles of ICT for development and outline a practical roadmap for a national ICT-enabled transformation strategy. The assertion by Hanna and Summer that "digital transformation encourages evidence-based policymaking, open and accountable institutions, partnerships, collaborations, and inclusive innovation (the means by which new goods and services are developed for and/or by those who have been excluded from the development mainstream (Heeks et al., 2013)" (p. xviii), is particularly salient in developing countries, where governance is too often an impediment to economic development. Most multilateral agencies that support emerging countries have made digital transformation and inclusive innovation a standard prescription and this is perhaps the most financially pragmatic reason why countries may pursue the tenets of digital transformation.

Part Two (Chapters 3 to 5) addresses three questions: How do we integrate ICT-enabled transformation into development? How do we transform government? How do we transform all other sectors of the economy? The steps the authors propose to integrate digital transformation into development policy are more comprehensive when viewed against other notable studies (see for example Heeks, 2008). Their analysis in these chapters blends well with my experience in government in Kenya during the formative stages of integrating ICTs into the national development agenda (Ndemo, 2015). Without the benefit of the knowledge expounded in this book, we started with the development of a shared vision (by seeking political will), aligned strategy with the national vision (Vision 2030), leveraged public private partnership to develop shared infrastructure in order to lower the cost of government's ICT agenda, and encouraged the industry to leverage the government's goodwill to develop inclusive innovations, such as the famed mobile money transfer system MPESA in Kenya.

In Part Three (Chapters 6 to 9), the driving questions include: What role should government play? How do we regulate the ICT sector? How do we develop a national broadband infrastructure and its strategy? What strategies do we need for implementing, monitoring, evaluating and adapting these strategies? Hanna and Summer's exposition in these four chapters is perhaps most illuminating for policymakers. Leadership, for example, is a highly subjective area and the authors have carefully avoided taking the widely held assumption that only Western leadership models work, by noting that "there is no single solution, and those that work well in some countries may fail in others" (p. 85). Indeed, the unique digital transformation in Rwanda has put that country on the global map, but the same cannot be said of Ethiopia, which has a similar government management style to Rwanda.

Regulatory agencies can become a major hindrance to economic progress when they apply rules without creating room for innovation. Perhaps this realisation is what led the authors to focus on the central role played by regulation by suggesting that "key public policy issues be examined for their impact on innovation, diffusion, and adoption of ICT" (p. 90). Kenya became the first country in the world to successfully enable and harness innovation in mobile money transfer under two different regulatory regimes, leading to unprecedented efficiencies. The authors' analysis on how to go about building a regulatory framework conforms to the experiences noted in Kenya, which suggest these may serve as a useful guide for other countries wishing to take a similar path. On the development of communication infrastructure, the authors diligently analyse the strategic policy decisions that would lower the cost of broadband, suggesting for example, that "infrastructure sharing allows telecom operators to develop common networks and share

costs, thus reducing investment and lowering prices" (p. 109). This is a welcomed proposition given that, in many cases, building broadband connectivity, like other costly communication infrastructure, is feasible because of public private partnerships (Ndemo, 2015).

Perhaps the greatest weakness in emerging countries is implementing, monitoring, evaluating, and adapting. As the authors point out, developing countries are increasingly employing methods of monitoring and evaluation in order to attain proper standards of continuous improvement. Although the authors suggest engagement with stakeholders as a strategy to develop a holistic vision and means of evaluation, social media is increasingly becoming a monitoring mechanism that is pushing policy makers to act in areas that, in the past, would have been ignored.

Key rhetorical questions thus remain: How well did Hanna and Summer present a holistic view of digital transformation? How relevant is the book to African policymakers and digital transformation practitioners? I would argue that they have been successful in presenting a fairly relevant and detailed book, but a few key areas were not addressed. As a case in point, due to low barriers to entry into the ICT-based enterprises such as business process outsourcing, many countries, especially in Africa, invested heavily in the sector as a strategy to create employment for the young population, without fully understanding the sector. Policymakers reading the book may be disappointed that the book does not provide the experiences of the IT-related industries, such as business process outsourcing, which are booming in places such as India and the Philippines.

Most other studies on ICT development (see Heeks, 2008) emphasise the role of developing "information literacy" among society as part of the complete digital transformation process, but the book fails to discuss this important factor. The Association of Colleges and Research Libraries (ACRL, 2014) defines information literacy as a set of abilities requiring individuals to "recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information". Developing this skillset is a challenge faced by many developing countries, in Africa and elsewhere, where it is often assumed that the level of literacy is higher than it is. This explains why a seemingly tech-savvy and information literate person could miss the digital transformation boat.

CONCLUSION

In conclusion, Transforming to a Networked Society: A Guide For Policymakers will undoubtedly serve as a valuable resource for policymakers seeking to learn the necessary steps to create an enabling policy environment for the smart economy. It will serve as a guide for industry practitioners on how to go about the transformation of the various sectors and should be recommended reading for students in business and ICT courses. For researchers, it provides a refreshing overview of current research on the role of ICTs in development and demonstrates how ICT scholars can benefit from a holistic analysis of digital transformation in a very dynamic sector.

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BRIEFING NOTE: PEOPLE-CENTERED INTERNET GLOBAL FORUM AT STANFORD: BEGINNING A NETWORK OF NETWORKS

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In a one-and-a-half day meeting, 24-25 October 2015, a diverse group of information and communication technology and development practitioners, academics, venture capitalists, policy advocates and social entrepreneurs met at Stanford University to chart a vision of an inclusive, people-centered Internet, and a forum to promote digital dividends for all. The meeting was chaired by Vint Cerf, Vice President and Chief Internet Evangelist at Google. The statement is available at http://peoplecenteredinternet.org/

The meeting recognised that, while the Internet and related digital technologies held great potential for mankind and have diffused much faster than previous technological revolutions, access to these technologies remains highly unequal, and potential payoffs have been limited by complementary factors: policies, institutions and capabilities. Universal, affordable, open, safe and secure access to the Internet can empower people and transform institutions. Yet the potential payoffs for the global poor have yet to be realised as they involve more than mere access. They require digital literacy, services and applications of critical relevance to local needs, local content in local languages, and community leadership and civil society organisations. Economic incentives, social regulations, and cultural factors also play a role.

The forum discussed the desirable properties of an inclusive people-centered Internet. This was illustrated by applications in the health sector, and by sharing the experience of several countries. The forum explored some key steps towards an inclusive Internet and digital technology ecosystem, one that would support the 2030 UN Sustainable Development Goals in education, health and other development objectives and would empower the poor, women, and youth with relevant content and capabilities to promote shared growth, and better equip future generations.

A quick summary of the four panel sessions reflects just how the application of ICT can transform and is transforming life as we know it, and highlights advances in the digital sphere that many citizens across the world would not experience by virtue of a firmly embedded digital divide.

PANEL I: HEALTH AND THE INTERNET

Among other presentations, Ted Chan and James Killeen discussed the San Diego BEACH initiative, which includes the use of data analytics for patient treatment and management of chronic diseases, pairing information and analytics with devices. The application of these tools and techniques to dreaded diseases such as MERS and SARS, and the utilisation of location-based services to identify public health risks, all impact on the healthcare of individuals.

Discussions arising from this panel centered on individual, family-, community- and global-level implications of the Internet for health. In particular, there was animated discussion of how to use the Internet to publicly: share health information that is anonymised, make family-oriented health information available in the cloud, permit other family members to navigate very young or very old people's health information that a patient may not be able to digest – "what did the doctor mean by this?" While using a trusted person as a gateway to understanding health information, this does raise ethical issues with respect to self-regulating health communities.

A few ideas that appeared to gain currency in order to clarify the meaning of people-centered Internet were (i) thriveability: communities could and should thrive because of greater health literacy through heightened availability of health information via the Internet; (ii) co-ownership of health data: in the case of Estonian citizens; and (iii) access to future innovations in mobile health-wearables: for example GPS-enabled shoes for persons with early Alzheimers.

PANEL II: CASE STUDIES OF HEALTH AND INTERNET INNOVATION

Madis Tiik of Estonia, an e-health innovator involved in changing the fundamentals of healthcare by making it more accessible and personal, spoke of the importance of trust, leadership, common infrastructure and the need for citizens to own their personal health data, in order to make e-health innovations work. In his comments on moving from health 1.0 to health 4.0, with health 3.0 being the analytics layer and health 4.0 being the personalisation layer, he spoke of the need to analyse and understand health data for better health decision-making. In 2015, Estonia started a pilot project of personalised medicine, including personal and environmental data, and proposals on how to use this information to create more predictive and more preventative healthcare.

Mei Lin Fung, of the Secretariat for the Global Forum, spoke of health and Internet innovation in Singapore. She argued that Singapore succeeded in maximising ICT investment because of the completion of projects, the high level of trust in the introduction of innovation, and the low levels of corruption in general and more especially in digital transition.

Ahmed Calvo, of the Stanford Haas Centre for Public Service, spoke on networked improvement communities in the health sector and discussed the context of 9,000 federally qualified health centres, 23 million patients and over 90 million patient visits per annum, from which data is aggregated and analysed. The lessons learned reflected on the community of practice created for front-line receptionists in a "24/7 beehive of communication". Here, the receptionists share knowledge on managing patient services; the transparency of data and analysis; and the power of social innovation motivated by information from 23 million patients.

A key discussion point on the meaning of people-centered Internet arising from this panel discussion was the focus on the family-centered health Internet – what it is, how it will evolve, how it will enable the family to self-define and self-determine improvements in family health.

PANEL III: DEVELOPMENT AND LEARNING IN A CONNECTED WORLD

Deepak Mishra, co-director of the World Bank's forthcoming World Development Report 2016: Digital Dividends, briefed the meeting on the report findings in the context of a discussion of the people-centered Internet. This led to the reflection that digital technologies raise the opportunity costs of not doing the difficult social and economic reforms, as well as the necessary investments in complementary factors such as policies, institutions, capabilities, incentives and regulation. The stakes are much higher for developing countries where these investments are often missing.

Mishra spoke about a typical day in the life of the Internet – 207 billion emails sent per day, 4.2 billion Google searches per day, 8.8 billion YouTube videos watched per day. He discussed the transformation to a digital marketplace for traders in both urban and rural parts of the world, and to digital identity formats used by millions of people to access public and private services. He noted that the digital divide is a policy problem (accessibility, affordability), not a technology problem.

In Nagy Hanna's presentation, he drew on his reviews of country experiences and practices to suggest a few lessons to take into account as we move ahead in the aim to realise digital dividends for all. Two gaps (misalignments, disconnects) must be overcome. The first is between investing in digital technologies and changing the socio-economic-political complementary factors. The second is between access to the Internet and other components of a vibrant digital transformation ecosystem, such as a digital leadership, human resources, local ICT services, and the local digital content industry. Hanna argued that we needed to understand the reasons behind the persistence of these gaps within countries and development agencies, and address them: turfs and silos, disciplinary biases, technological determinism, etc. Hanna also called for enabling locally led initiatives and grassroots innovations, as well as top-down policies and reforms, to scale up the promising ones within their diverse contexts.

Policy makers play a crucial role in creating the enabling policies and institutions, so it would be important to develop compelling narratives to influence decision makers and engage them as agents of change to transform their economies, institutions and societies. In many ways, these lessons resonated with the policy advocates who participated at the forum.

The panel posed the question: What will be the tipping point in moving from a focus on infrastructure to a focus on e-services and digital transformation of economy and society? This question is important in a context where many developing countries have a relatively decent digital platform to work on, but the investments in e-services and complementary contributors to transformation are much lower. The panel also highlighted the Internet of the small and informal business sectors as a key to realising shared prosperity and an inclusive people-centered Internet.

PANEL IV: COUNTRY EXPERIENCES IN PURSUING NATIONAL DIGITAL TRANSFORMATION

Virgilio Almeida, National Secretary for Information Technology Policies in the Brazilian Ministry of Science, Technology and Innovation, presented a set of Internet facts and figures for Brazil, noting the presence of 105 million Internet users out of a population of 210 million in 2014 and the growing importance of ICT in health, electronic government and Brazilian schools.

Almeida raised the debate of the false dilemma of spending on ICT versus spending on infrastructure and poverty, and commented that digital transformation strategies and economic agendas are regrettably not seen as complementary or supplementary. Almeida reflected on the difficulty in working with disruptive technologies and mastering digital transformation, hence the need for transformation strategy to be part of the economic and political agenda of countries and governments.

Bitange Ndemo, former Permanent Secretary in the Kenyan Ministry of Information and Communications, explained that the mobile money application M-Pesa had changed the nature of digital transformation in Kenya.

Ndemo also spoke of digital transformation pilots in healthcare, education, agriculture, and the judiciary. He argued that success in specific e-initiatives could (i) lead to savings of up to 40% in public healthcare budgets through applications with respect to non-communicable diseases, e.g., tests for malaria, typhoid and other diseases, which consume up to 50% of the health budget, and (ii) free up doctors to look at more serious diseases by introducing an incentive programme to move the non-communicable diseases onto electronic platforms.

M-Pesa had given the Kenyan government the confidence to introduce ICT innovations, but legal frameworks needed to change, which could take years to reform. And existing systems do not allow risk taking for innovation purposes.

Lucienne Abrahams, Director, LINK Centre, University of the Witwatersrand, a research centre in policy and regulation, spoke of the lived experience of mobile and Internet communications for the majority of communities with low and very low household income, reflecting on multiple forms of value: money proposition of Internet usage (every cent counts); electronic communications to keep the household or family connected; limitations of access to affordable services and applications such as Skype; and use of social media by rural communities to share experiences of health facilities (Kgabo clinic in Winterveldt, South Africa).

Abrahams argued that policy must meet the challenge for "resilient success" – it should seek to extend the role of the private sector even more strongly towards digital inclusion innovations. Policy should aim for a government contribution that starts at the end of the spectrum of digital transformation closest to where the most disadvantaged citizens are, and farthest away from private sector interests, for example e-education and e-health in the public sphere. While public-private partnerships (PPPs) are often lauded, they have rarely come together in African contexts, because of the complexity of the risks faced by both parties. Public-private sector collaboration may have more value than formal PPPs.

SUMMING UP

One of the emerging themes of the forum is the exploration of the meaning of a people-centered Internet, in other words an Internet of the people, by the people, and for the people. A new debate can and must ensue with respect to creating new meanings and new values for the Internet era. This can include family-centered e-health innovation, community- and women-centered incentives for economic and social change, and small-business-centered Internet innovation for value creation.

Policy-making must focus more on people than on technology. It needs to become diversity-oriented and include culturally open-minded perspectives on what people want from the Internet, as well as address the availability and affordability of student-oriented computational power.

What then is the role of policy-makers, scientists and innovators in creating a people-centered Internet, that is global, benefits all parties, fosters human networks for good and is connected electronically? In these circumstances, it will become increasingly important to move towards a greater emphasis on socially-oriented regulation side by side with economically-oriented regulation. The people-centered Internet can be more than the Internet of Things (IoT) – it can be the Internet of People (IoP).

The other recurrent theme of the forum is the urgency to realise the promised digital dividend for all. Access to the Internet and other digital technologies remains a necessary, but not sufficient, condition to digital transformation. It aims to induce, scale and sustain deep changes in economies and institutions and thus realise the substantial payoffs of ICT.

There is an urgent need to understand the process of digital transformation and harvest the rich experiences and innovations of the many countries pursuing such transformation of their economies and societies. This calls for evaluative research, systematic experimentation, and knowledge sharing in best practices in national policies and strategies to advance digital transformation in government, economy, and society.

In order to realise digital dividends, it will take political commitment and long-term persistence to overcome institutional barriers. Further, it will require close interactions between ICT and development professionals to integrate digital technologies into countries' economic transformation strategies. These strategies will need to mobilise stakeholders and build local partnerships to secure inclusive and sustainable transformation.

We welcome comments and feedback on how to advance this vision of people-centered Internet, and of inclusive digital transformation for countries at all levels of development.

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