GLOBAL TRENDS IN MANAGEMENT, IT AND GOVERNANCE IN AN E-WORLD (E-MIG 2017) INTERNATIONAL CONFERENCE

Conference Proceedings

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INSPIRING GREATNESS
MESSAGE FROM CONFERENCE CHAIR: DR ALBERT VAN JAARSVELD (UKZN)

This conference proceedings document highlights contemporary knowledge generated by academics, post-graduate students, researchers, IT practitioners under the overarching theme: Global Trends in Management, IT and Governance in an e-World.

As co-hosts of the inaugural e-MIG 2017 Conference in collaboration with Mauritius’s Open University, our vision was to create a platform that encourages dialogue and the enhancing of knowledge and views among experts that are shaping the emergent e-World. These conference proceedings demonstrate that we have largely achieved this ambitious goal.

The papers featured herein offer insights into a range of disciplines in the Management, Information Technology (IT), Law and Governance fields. All authors are emerging and/or seasoned researchers who are looking forward to feedback and secondary discussions that will benefit their research and thinking.

Conference participants coming from South Africa, Mauritius, India, Botswana, Namibia, Nigeria and Tanzania. The contributions also reflect the multidisciplinary approach that was adopted with the explicit intention of contributing to solutions for global challenges by highlighting how IT supports a growing digital economy through facilitating effective and efficient Management and Governance. Not only are we hoping that this conference will result in new exciting research collaborations but it is our hope that the wealth of experience and knowledge shared during the three days will strengthen African scholarship and global e-MIG practices.

On behalf of the Organizing Team, I am pleased that you agreed to join us on this journey and were part of this learning, sharing and networking experience. To our co-host, the Open University, we look forward to exploring more similar collaborations into the future.

Dr Albert van Jaarsveld
Vice-Chancellor and Principal
University of KwaZulu-Natal
MESSAGE FROM CONFERENCE CHAIR: DR KAVIRAJ SHARMA SUKON (OU)

This Conference Proceedings contain the written versions of most of the contributions presented during the Global Trends In Management, IT and Governance in an e-World (e-MIG 2017) International Conference held in Mauritius during 8 to 10 November 2017.

This conference has been the fruit of close collaboration between Open University of Mauritius (OU) and the University of KwaZulu-Natal (UKZN). The theme reflects the needs of the countries in the region. It provides the key ingredients for a successful connected e-World. In fact, in this time of economic challenge, we need to adopt a multidisciplinary approach. This conference provided an opportunity for researchers from various fields, including Management, Information Technology (IT), Law and Governance to discuss problems of common interest. This gathering of experts went beyond presentation of research papers. It established a network of researchers, academics, administrators, practitioners, and graduate students who can collaborate to conduct research. The papers reflect the high standards of research in these fields. This conference has also given a platform to the doctoral students to present their research work as well as to interact with the seasoned researchers and discuss their work. This Conference has also contributed to the development of leadership, capacity, and scholarship in the African region.

I would like to thank all the participants for contributing to the success of this conference that we hope will become an annual one. My sincere gratitude goes to all the members of the organizing team from OU and UKZN who have been working relentlessly for more than a year prior to the conference. I would like to present my special thanks to Dr. U G Singh (UKZN) and Mr. P Appavoo (OU) for their dedication.

Dr Kaviraj Sharma Sukon
Director General
Open University of Mauritius
MESSAGE FROM CONFERENCE ORGANISING CHAIR: MR PERIENEN APPAVOO (OU)

“The human mind is inquisitive in nature; translating this inquisitiveness within an epistemological paradigm is what generates empirical research work”

This e-MIG conference emerged as the fruit of an extensive discussion between the staff of the Open University of Mauritius and the University of KwaZulu-Natal and aimed at providing an international platform for academics and researchers from different continents to share expertise and knowledge in the fields of Management, Information Technology, Law and Governance in a world which is e-driven. This unmatched collaboration between these two universities should spearhead south-south educational cooperation and set the pace for a sustained research agenda that will profit the African continent and beyond.

This conference contributed to the knowledge building process by providing a forum for scholarly discourse on the selected themes using localized analysis as well as comparative perspectives. Against this backdrop, e-MIG generated original research and other scholarly creations of academic value to enhance our processes and make a better world for our citizens. Through the lens of this compilation, we are submitting some innovative research articles that will hopefully initiate critical discourse at all levels in order to create new theoretical as well as practical insights in the local, national, regional and international contexts.

My sincere wish is that through this conference we have all embraced an additional stepping stone to escalate to higher heights in our research endeavors. And Mauritius was proud to offer its warm weather and the white sand of its seashores as the conference conducive environment for this productive interaction to take place.

It has been my pleasure and privilege to collaborate with dedicated academics from both OU and UKZN and would like to particularly place on record the commitment of Dr Upasana Singh.

Fruitful reading!

Mr Perienen Appavoo
Organizing Chair (Mauritius)
Senior Academic Media Coordinator
Head of Research, Consultancy & Innovation
Open University of Mauritius
MESSAGE FROM CONFERENCE ORGANISING CHAIR: DR UPASANA G SINGH (UKZN)

The first multidisciplinary conference on Information Technology, Law, Management and Governance (e-MIG) served as a platform for academics from varying disciplines to meet, engage and collaborate on research topics. I sincerely thank the Director General of the OU of Mauritius, Dr Sukon, and our UKZN Vice Chancellor, Dr Albert van Jaarsveld, for their support in all aspects of this conference. To the dedicated teams at the OU of Mauritius and UKZN, and our reviewers, a special thank you to all of you for your selfless commitment.

A total of 146 papers were submitted for this conference, from 8 countries, which include the host countries of South Africa and Mauritius, as well as Zambia, Tanzania, Zimbabwe, Botswana, Nigeria and India. After a rigorous double blind review process 123 papers were accepted for presentation, on a range of topics within the disciplines of Information Technology, Law, Management and Governance.

This proceedings presents a compilation of selected reviewed papers, on each of these themes, and thus makes interesting reading, on a diverse range of topics. We thank all the authors who chose to publish their paper in these proceedings, without whom we would not have had the opportunity to publish.

As the saying goes, “variety is the spice of life”, so I hope this reading enhances your knowledge and provides you with an enlightening reading experience.

We hope that you will join us for this exciting conference in the future.

Dr Upasana G Singh
Organizing Chair (South Africa)
Lecturer: Information Systems & Technology
University of KwaZulu-Natal
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Implementing and Managing ICT in Education – Perspective of Mauritius as a Small Island Developing State (SIDS) in Africa: A situational case study

Ricaud Auckbur, Anita Bassoo, Ashvina Parboteeah, Kavita Purmessur, Nasreen Jowaheer
e-Education department, Ministry of Education and Human Resources, Tertiary Education and Scientific Research, Mauritius
rauckbur@govmu.org

Abstract

This paper presents, through a situational management case study approach, the experience of Mauritius in the management and implementation of measures in promoting development of ICT in Education. It describes the adoption of technology deployment, development of resources and training as important elements in ensuring a coherent strategy for implementation and use educational technologies in a small island developing state context in Africa. The paper finally makes recommendations on the improvement of the deployment of measures in ICT in Education in Mauritius, with a view of guiding policy in improving this sector which is critical in the development of a knowledge society in a small island state context.

Keywords: Education technologies, ICT in Education, Educational management through ICT, Implementing ICT in Education, Structuring ICT in Education, ICT in SIDS

Background of the Mauritian Education System

Mauritius is a country situated 1500 Km east of the Mozambique Channel in the Indian Ocean. It is an island of volcanic origin with coral reefs circling the coastline. The island has a population of 1.3 million inhabitants (2016). It is a pluricultural society comprising: Hindus, Muslims, Creoles, Chinese and Europeans. The population is primarily multilingual with Mauritian creole as the lingua franca, and French and English being widely spoken. English is the official language, several Indian languages, along with Mandarin and Arabic, are also taught in schools.

The Education System

The Education system in Mauritius is mostly adapted from the UK system, given that country was previously a British colony. Education has been a main focus of all governments since Independence in 1968, given that its human resource being mostly its only valuable resource on land.

The present education system is a 2+6+5+2 system. It starts with two years of pre-primary, followed by six years of primary schooling. The educational path goes on to five years of secondary leading to the “O” and concluding with two years of “A” level. School courses are taught in mostly in English, and O-level candidate choose their subject options with English, Mathematics and French as compulsory. The school year begins in January for both Primary and Secondary Sectors. The O & A level exams are held in October/November with results in February.
Higher Education, comprising Universities, polytechnics & vocational Training, is currently offered at various levels by a number of institutions from both the public and private sectors.

The Mauritius Education system has accordingly been a strong contributor to national development, and all governments have always strived to enhance Education at all levels. The system is also supportive to vulnerable groups to engage in Education. It provides for free, universal, compulsory primary and secondary education, along with free transportation to schools, free textbooks, and a growing offer of degree education in Universities in Mauritius. Support is also provided to registered aided secondary schools.

The Education system nevertheless faces a number of challenges that are addressed through the undergoing reform agenda. There is a focus on provision of relevant 21st century skills, encouraging pathways to employment, and there is a need for employees with high level skills, capable of critical thinking and who are problem-solving. The present educational reforms thus has for aim to prepare students at all levels to be successful and confident world citizens.

**Methodology and Literature Review**

A review of existing literature in ICT in management of education has first been engaged upon after which discussions have been held within the department, with other Ministry departments and also with external institutions involved in ICT in Education. These discussions have contributed to enrich the presentation of the situational analysis and also to come up with recommendations on improving the sector.

The introduction of ICT in supporting the world of Education is one of the critical components of building knowledge and competencies in a growingly globalized and technological environment.

This process of digitization of knowledge starts at a very early stage of Education and Lu et al., 2015, along with Bennett et al., 2008 in (Sohawon, Panday and Baxou, 2016, 104) thus point out that that ‘students entering schools are already ‘digital natives’ and the modes of teaching need to change because learners are changing by growing up in a digital world. It is a necessity that schools need to accordingly keep up with the responsibility to build on this foundation to meet the challenges of the digital world in order to realize students’ full potential’.

In continuity of the above, it emerges that schools put much emphasis on the integration and adoption of ICT. Anderson 2010 in (Sohawon, Panday and Baxou, 2016, 104) in this respect argues that ‘before the ultimate ‘transforming’ stage is reached, schools at the ‘applying’ stage must have acquired ICT equipment throughout their organization and where school administrators use ICT for more organizational and management tasks’. ICT is consequently considered a powerful tool for educational change and reform.

Lowther, et al. 2008; Weert and Tatnall 2005 in (Shan Fu (2013, 112) state that previous studies point out that an appropriate use of ICT can raise educational quality and connect learning to real-life situations. As Weert and Tatnall (2005) in (Shan Fu (2013, 112) illustrate,
learning is an ongoing lifelong activity where learners change their expectations by seeking knowledge, thereby departing from traditional approaches.

The importance of tapping the potential of emerging mobile technologies in Education is also strongly echoed by international organizations. The UNESCO Policy Guidelines for Mobile Learning, illustrate that mobile technologies provide further educational opportunities for students in a diversity of contexts, and that mobile equipment and mobile phones in particular – are being increasingly utilized by schools around the world to access information, and open educational resources, and provide learning in a growing diversity of methodologies.

From the perspective of national policies, Kozma R.B. (2005) mentions that policy makers and project leaders are encouraged to perceive ICT as one of the elements that can impact in improving education. This is well illustrated in Policy documents in ICT in Education worldwide, with for instance the ICT in Education Policy paper of Turkey (2005) showing that the previous models of traditional rote method of learning do not encourage the integration of ICT in education. The discussion also indicates that to get optimal benefit from new technologies, there is need to be a change in the attitudes governing education. Teachers do determine new ways to take advantage of the fast-evolving technology, concluding that it is essential that resources must be provided to teachers and students to encourage them to adopt innovative ways to use the technology.

**The Structure of Educational Management in Mauritius**

The Education system in Mauritius is governed by the Ministry of Education and Human Resources, Tertiary Education and Scientific Research. The Ministry is centralized with the Headquarters engaging in governing Education and Human Resources at the national level, and decentralized structures called Zone Directorates have been set up to engage in education in the four geographical zones of education (School Management Manual, Ministry of Education, Culture and Human Resources, 2009).

**The current Education System**

The Education system in Mauritius consists of the Pre-primary, Primary, Secondary, Polytechnics and Vocational Education and Training (TVET) and Tertiary Sectors. The Ministry is currently engaged in a major reform programme which makes the development of the whole child a reality through not only the development of knowledge but also of skills and values that are required to be successful in a 21st century environment.

**Pre-primary Sector**

The pre-primary Education in Mauritius begins with age of 3 and goes up to 5 years old. The pre-primary sector comprises Pre-primary Units (PPUs) for Government Schools and Preschools for private sector, which is regulated by the Early Childhood Care and Education Authority (ECCEA). The mission of the ECCEA is to provide equal access for all children to quality pre-schooling, including those at risk of delayed development and disabilities, through a child-centered and play-based approach, along with the involvement of the parents.
Primary Sector

Children start primary schooling as from the age of 5 or 6 years old. This schooling begins with Grade 1 and progresses up to Grade 6. With the new reform being implemented this year which is the Nine Year Continuous Basic Education (NYCBE), the Certificate of Primary Education (CPE) has been superseded by the Primary School Achievement Certificate (PSAC) at the end of Grade 6 as from 2017 onwards.

Secondary Sector

With the introduction of the NYCBE, after completing Grade 6, students are admitted to a regional secondary schools. The structure of the Secondary schools will be as follows:

- Grades 7-9 - Basic Education (Lower Secondary) - Regional Secondary Schools
- Grades 10-11 - Upper Secondary - Regional Secondary Schools / Academies
- Grades 12-13 - Upper Secondary - Regional Secondary Schools / Academies / Polytechnics

As from 2020 onwards, the introduction of a National Certificate of Education will be given to students of Grade 9 after final examinations; and the setting up of Academies which will run classes from Grades 10 to 13 and specialize in certain streams/subjects, and of Polytechnics.

TVET

The main public provider of the TVET is the Mauritius Institute of Training and Development (MITD). The objective of the MITD is to provide technical courses to provide human resource training to meet the needs of the world of work at the vocational level. The MITD also currently provides courses at the level of National Diploma. The TVET sector is regulated by the Mauritius Qualifications Authority which also develops and maintains the National Qualifications Framework (NQF)

Tertiary Sector

Tertiary education in Mauritius is characterized by a wide range of institutions providing students with a growing diversity of opportunities. A number of the institutions are awarding bodies that are overseas with their provisions made available through the distance education and mix mode. Within the public sector, tertiary education revolves around the leading institution which is the University of Mauritius (UoM), the University of Technology (UTM), the Mauritius Institute of Education (MIE), the Mahatma Gandhi Institute (MGI), the Mauritius Institute of Training and Development (MITD) and the Open University of Mauritius (OUM). Overseeing the four tertiary education institutions (TEIs) is the Tertiary Education Commission (TEC) which, inter alia, is responsible for the provision of public funds, along with the coordination of the development of post-secondary education and training.

Many Mauritian students also either proceed overseas for higher education, or engage in distance learning with foreign universities.
Managing Information & Communications Technology (ICT) in education in Mauritius

The introduction of ICT in schools started in 2002 with the inception of the School IT Project (SITP) prepared by the Ministry of Telecommunications and Information Technology in collaboration with the Ministry of Education and Scientific Research in 2000-2001. The SITP covered the pre-primary, primary, secondary and vocational sectors but the first priority of the project was then the Primary School Sector.

In line with the reform proposals contained in the Primary School Curriculum Renewal of March 2001, ICT was first introduced as a subject in primary schools – as from January 2003 - before being integrated across the system a few years later.

A School IT Project Division was set up at the Ministry of Education and Educators were seconded for duty to manage and co-ordinate the whole project until a proper unit was set up in 2003 with grades Manager (ICT) and Assistant Manager (ICT) to implement and monitor ICT projects in schools. The Section was reinforced in 2007 through the recruitment of 5 ICT Technicians whose main responsibility was to ensure the proper functioning of the School ICT Infrastructure.

At the level of the Ministry of Education & Human resources, Tertiary Education and Scientific Research, the e-Education directorate was then created in 2011 with the responsibility of managing all ICT related projects in primary and secondary schools. The directorate focuses on the coordination with regards to policy advising, implementation and mentoring of all ICT related projects in Education. The directorate has been strengthened in 2017 with the appointment of senior staff at both pedagogical and technical levels along with an Assistant Manager, 4 additional Principal ICT technicians and 5 additional ICT Technicians.

The Current ICT in Education Platform in Mauritius

There are 278 Primary schools in Mauritius including Rodrigues and Agalega. The schools in Mauritius are distributed in four geographical areas as in Table 1 below.

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Rodrigues</th>
<th>Agalega</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td>74</td>
<td>60</td>
<td>41</td>
<td>17</td>
<td>2</td>
<td>278</td>
</tr>
</tbody>
</table>

In 2002-2003, computer rooms were set up in primary schools. At present, each school is equipped with at least a computer room with an average of 20 Personal Computers (PCs), a printer and a digital projector. There are in all a park of about 4,150 PCs with a major challenge being a growing number of obsolete Windows XP PCs, which the Ministry is progressing replacing over the next 2 years.

In order to improve the teaching/learning process, in 2011, the Sankoré Project, that is the digitization of classrooms, started with a donation of digital interactive projectors and laptops.
from the French Government. Over the past years, the Sankoré project has been successfully implemented in Standard IV-VI through the support provided both by the French Government, and through Government funding. The French Government donated 1109 projectors and laptops and the Ministry of Education & Human resources, Tertiary Education and Scientific Research has procured 655 sets of equipment to equip all Standard IV-VI classrooms in Mauritius and Rodrigues.

In 2017-2018, the Early Digital Learning Programme for Grades 1-3, will bring about a sharp increase in the number Information Technology (IT) equipment in primary schools in the form of tablets PCs, rack chargers, projectors and projector screens.

Promoting high speed connectivity in schools is underway. Currently, each primary school is connected to the internet at a speed of only 1 Mbps. The Ministry of Technology, Communication and Innovation (TCI) is currently engaged in the deployment of broadband 10 Mbps to be completed by Dec 2018. ICT is taught as a subject by ICT Support Officers in primary schools. The Ministry currently has 148 ICT Support Officers (ICTSOs), with the result that ICTSOs have to be deployed to serve more than one school. The Ministry has, in June 2017, launched a call for the enlistment of Supply ICT Support Officer to provide improved teaching of ICT in Primary Schools. These Supply Officers will assist the current pool of 148 ICT Support Officers in better delivering teaching and learning of ICT in Primary Schools in the light of inclusion of ICT as Non-Core subject in PSAC 2018.

At the secondary level, there are in all some 62 State Secondary Schools and 5 Mahatma Gandhi Secondary School (MGSS) distributed across the 4 zones as per Table 2 below.

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Rodrigues</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>17</td>
<td>13</td>
<td>15</td>
<td>0</td>
<td>62</td>
</tr>
</tbody>
</table>

Each school is equipped with at least one ICT laboratory. There are approximately 2,500 PCs in state schools. In addition, tablet PCs were distributed to students of Form IV and V and educators in 2014. ICT is taught as a subject by Educators Secondary and each school has one or more IT Laboratory Auxiliary to take care of the equipment in the ICT laboratory.

Each secondary school is currently connected to the internet at 2 Mbps but the Ministry of TCI has already completed the deployment of broadband at 10 Mbps and planning its operationalization by end of 2017. With the advent of high speed connectivity, opportunities to provide access to Open Educational Resources (OERs) can be tapped into to enhance both teaching and learning.


Projects in ICT in Mauritius

The Education system in Mauritius has experienced continuous growth in terms of initiatives in introducing technology as a tool to assist education. The projects have provided classes and teachers with technological platforms to enable schools to enhance pedagogical and managerial practices in line with 21st century learning strategies.

Projects in the Primary Sector

(a) SchoolNet

Since 2007 Primary schools have been connected to the internet with Broadband Asymmetric Digital Subscriber Line (ADSL) - 1 Mega Byte (Mb). WiFi modems are available in all computer labs and schools have official email addresses. The Ministry of TCI is currently making provision for high speed internet connectivity (10 Mb) to all primary schools through more advanced technologies such as fibre optic connection.

(b) Sankoré Project

The Sankoré Project was introduced in 2011 with the receipt of equipment (interactive projectors and laptops) from the French Government. This digitalization of classrooms started with the Standard IV classrooms and has now been extended to Standard V & Standard VI classrooms in all Primary schools in Mauritius and Rodrigues.

Some 1500 projectors have been installed in Standard IV to VI classrooms. The project is now being expanded to other sectors such as Special Education Needs (SEN) Schools.

The Mauritius Institute of Education, being the teacher training institute in Mauritius, has been designated as the body responsible for the training of all Primary School Educators along with the training of Headmasters, ICT Educators and School Inspectors. A programme has also been set up for the production of contextualized e-Learning contents and text books are now available in digital interactive versions.

(c) Early Digital Learning Program - EDLP

In line with the strategy stated in Budget speech 2016/17 of “MOVING TOWARDS A FULLY FLEDDGED DIGITAL SOCIETY”, the Ministry is deploying tablets in primary schools. To develop digital literacy at the primary level, digital tablets and relevant online and offline educational resources will be provided to pupils of Grades 1 and 2.

The use of tablets in Primary schools is to support, enhance and transform the learning experience to improve learning outcomes for pupils at the very earliest stages of education. This will encourage an early culture of IT usage and practice as a tool to enhance primary education. Both Cloud-based and offline Educational contents, validated through the Mauritius Institute of Education, will also be provided for use with the tablets. This deployment of Tablets is being carried out in phases over 2017-2021.

For this major project of introduction of mobile technologies in primary school classrooms to be meaningful and effective, primary schools need to have the proper internet
connectivity. The Ministry of TCI has launched a tender for provision of high speed internet connectivity (10 Mb) to all primary schools in Mauritius and Rodrigues.

Projects in the Secondary Sector

For the secondary sector, which was the second priority of the School IT Project, there was mainly capacity building in the short term and offering of Computer Studies/Computing Courses in schools.

All secondary schools are equipped with Computer Labs and in 2006 broadband internet access (1 Mb) was provided to all schools, with internet extended to school libraries and the administrative block a few years later. In 2010, each science lab was equipped with a laptop and projector for enhanced teaching/learning.

(a) Tablet PC project (2014)

The Ministry (MOEHR) provided Tablets PCs to Form V students in 2014. These Tablets were equipped with relevant pedagogical content and access to online resources for enhanced teacher-student and student-student interactions was made possible. This initiative had for objective to induce a paradigm shift in the teaching and learning process at Secondary Level so as to improve students’ learning by providing them with anytime, anywhere opportunities to become independent learners through technology. Training was provided to Educators on Train the Trainer basis. Pedagogical contents were prepared by the Mauritius Institute of Education (MIE).

(b) SchoolNet II

All State and Private Secondary Schools are currently being equipped with high-speed secure Internet links of 10 Mbps and wireless connectivity in Form IV and V classrooms through the SchoolNet II Project driven by the Ministry of Technology, Communication and Innovation. WiFi will also be available in the yard through a wireless hotspot. An optimized use of the SchoolNet II Infrastructure can be made by Educators in the teaching/learning process since many Online Educational Resources (OERs) are available.

(c) School Website

The Ministry of Education and Human Resources in collaboration with the Government Online Centre (GOC) is currently engaging in the training of schools in the setting up and hosting of school websites under the Government online Centre platform for 62 State Secondary Schools.

(d) e-Register System

With the aim of reducing truancy at school, the Ministry of Education and Human Resources has put in place a system whereby alerts via Short Message Service (SMS) are sent to responsible parties if their ward is absent from or late at school. At the level of schools, as soon as students’ attendance have been recorded in the morning, data for all absentees are sent to the GOC where a message is automatically generated and sent to parents who have opted to receive the SMS.
(e) **Student Support Programme**

The aim of the Student Support Programme (SSP) is to provide additional support to Grades 7-9 Students and give them more ownership of their learning. It will also help them to become independent learners. It may help to address the causes of private tuition.

All Grade 7 and 9 students and educators will be provided with online digital resources adapted to the National Curriculum Framework for Lower Secondary in Mauritius. Online resources are being developed by the MIE and the Open University of Mauritius (OUM). As all Secondary Schools are currently being equipped with high-speed secure Internet links of 10 Mbps, wireless connectivity in Form IV and V classrooms and Wi-Fi in the yard through a wireless hotspot, Educators and Students would be able to connect to the platform from any location at any moment and on any device to have access to a choice of open educational resources that will be available online.

(f) **ICT Corners in the staff room**

ICT Corners are being set up in the staff room of secondary schools so as to enable educators to fully tap the potential of high speed connectivity being put in place through the SchoolNet II Project.

(g) **Deployment of Microsoft Office 365**

Office 365 is a cloud-based office and education solution from Microsoft that gives the possibility to use Microsoft Online (Word, Excel, Mail, PowerPoint, One Note, Skype for Business). This platform, is being deployed in the first stage to State Secondary schools. With this public-private partnership, the Ministry is envisioning the Office 365 cloud platform as one technology facilitator for pedagogical and education management information systems (EMIS) as part of the NYS reform process.

(g) **E-Timetabling Software**

Ministry is purchasing an E-Timetabling Software for 62 State Secondary schools, 4 zones and Ministry’s Head Quarters. The aim of the E-timetabling software is to ease school administration by harmonizing the way timetables are worked out across all secondary schools. This software will enable school timetables to be created automatically making optimum use of all resources available.

**Use of digital educational resources in Mauritius**

Teaching aids have been long utilized in Education to enhance or enliven classroom instruction through technology. These have ranged from the use of overhead projectors and slide projectors in the 70s, to the use of television in the 80s through the Mauritius College of the Air (MCA) and as from the 90s with the expansion of the use of computers, first in dedicated computer rooms and subsequently growingly on a ubiquitous basis with digital technologies becoming more affordable and accessible to schools and in classrooms.
The fast development and diffusion of information and communication technologies (ICT) have thus led to a significant impact from the traditional model of educational systems and teaching and learning methods in Mauritius. The growing ease of access to digital education content and the growth and affordability of connectivity are strong contributors to the improvement of educational quality, which is particularly important for relatively isolated and developing countries such as Mauritius.

**The Rationale for Using Digital Educational Resources**

The use of digital resources in Mauritius have been through the usage of education tools that have been facilitated by technology, or inspired by instructional practice that makes effective use of technology. Examples of such learning tools that have been used include, but are not limited to:

- using laptops and digital projectors as instructional tools
- accessing digital content through online and offline software
- using technology to assist experimentation in science through data logging software
- using technology to connect, collaborate, curate and create.
- Encouraging a culture of early programming concepts in students, including training in robotics
- assessment and reporting online
- game-based learning
- active participation in online communities

**Project example 1: Production of contextualized digital resources for the Sankoré project**

There has thus been several projects which have successfully been deployed alongside with the relevant framework for production of digital resources. On the Primary side, the Sankoré project was well received by all stakeholders in the Primary Education sector - teachers, pupils, parents and other partners. Children have been very enthusiastic as it provides an expanded opportunity for learning along with contextualized knowledge acquisition through the use of technology.

A survey carried out by Ministry in Mar-Apr 2012 revealed that around 68% of schools were very enthusiastic to use interactive projector with laptop for teaching in the classroom.
One important aspect of this project has been through the use of the Open Sankoré software, as an open Educational Resource (OER) which has provided teachers with a flexible platform to use, adapt and create new content using the digital interactive projectors. This model of adaptability of use and of fostering creativity in the preparation of resources has been well received by teachers through training by the Mauritius Institute of Education, and has also been evidenced through international research.

In terms of training, eight regional training centres, two in each Zone, have been set up and equipped with appropriate interactive tools.

**Project example 2: The Scratch programming project**

A second project for which digital educational resources have been creatively used in the Education sector in Mauritius has been an introduction to early programming through a piloting of the use of Scratch software in schools. The objectives of this project had been to provide the necessary framework for students to develop competencies in principles of Computer Programming and thereby ensuring that mid secondary (Form III) students acquire the minimum skills for effective thinking, problem solving through a graphical programming environment using MIT Scratch. The project also motivated students for further learning through playfully experimenting and creating projects such as interactive animations and games, and empowered students at a young age to develop a solid foundation of knowledge that can help prepare them for the use of higher level programming languages.

**Project example 3: Digital Educational Resources for the Early Digital Learning Programme for Grades 1 and 2**

The project has for objective to develop digital literacy at the primary school level. Digital tablets and relevant online and offline educational resources will be given to pupils of Grades 1 and 2.

In this project, Primary schools are being equipped with pupil-adapted rugged mobile devices (tablets or hybrid devices) for use by Standard I-II educators and pupils within classrooms. This will encourage an early culture of IT usage and practice as a tool to enhance primary education. Both Cloud-based and offline Educational contents, validated through the Mauritius Institute of Education, have been provided for use with the tablets. This deployment
Partnerships in ICT in Education in Mauritius

Rationale and models for partnerships

Successful partnerships in ICT have been important contributors to ensure the success in the deployment of educational technologies, in particular in the context of a small island developing nation that is relatively isolated from the major global digital information highways. In Mauritius, attention has been laid in such projects on the definition of agreed intended development outcomes, and on ensuring that there is sustainability into partnerships by involving local stakeholders, the local community, and paying particular attention to the local context within which any such partnership is implemented.

It is also deemed essential for ICT for education initiatives to begin with the educational targets as the principal area of focus. Initiatives brought in through such partnerships are perceived as not only being about introducing computers or mobile devices into schools, but also need to be focused on how the specific educational needs can best be delivered through such digital tools.

There are thus various models of partnership that have been adopted, ranging from the provision of seed funding, Build-Operate and Transfer (BOT) processes on a “locked-stocked-and barrel” delivery basis, donation of equipment, along with venture schemes delivered formally through partnership agreements.

The resilience and sustainability of such partnerships is particularly of importance. In this respect, international development partners, donors, private sector organizations and, sometimes, even philanthropic agencies have started partnerships in the funding of pilot projects but is consistently the danger of the inability of the local agencies to the then meet the challenges of successfully transforming such pilot projects into national programmes. Particular care has been exercised in the Mauritian context in this respect, with caution having been applied in some cases on the choice and credibility of partners in some cases of unrealistic projects for which there were clearly undefined elements in terms of sustainability.

Exemplars of successful partnerships in ICT in Education in Mauritius

Major partnerships have been developed in ICT in Education in recent years both through Multilateral and Bilateral projects, along with collaboration with the private sector. On the Bilateral side, the most prominent one has been with the French Government on the Sankoré Project, and the current collaboration with the UNESCO International Institute of Technology in Education (IITE) is the main one on the multilateral side. The Ministry and Government have also engaged into agreements with the private sector, such as with Microsoft through the Partners in Learning and Digital Transformation programme.

Also, worth noting, on the bilateral project side, is the existing cooperation with the Government of India for the implementation of the Early Digital Learning Programme. In this project, Mauritian primary schools are being equipped with pupil-adapted rugged mobile devices (tablets or hybrid devices) for use by Grade 1 and 2 educators and pupils within
classrooms. This will encourage an early culture of IT usage and practice as a tool to enhance primary education. Both Cloud-based and offline Educational contents, validated through the Mauritius Institute of Education (MIE) and the Mahatma Gandhi Institute (MGI), are also being provided for use with the tablets. This deployment of Tablets is being carried out in phases over 2017-2019.

**A SWOT analysis of ICT in education in Mauritius**

The matrix below presents a SWOT analysis of the described measures in the management of ICT in Education in Mauritius.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• All schools have computer labs/rooms</td>
<td>• Internet connection present in all schools, but at relatively low bandwidth</td>
</tr>
<tr>
<td>• All schools equipped with desktop PCs</td>
<td>• Isolation as a small island state results in a relatively low awareness of latest technological platforms and good practices in ICT in Education</td>
</tr>
<tr>
<td>• All offices of heads of primary/secondary schools equipped with desktop PCs</td>
<td>• Challenges in technology adoption in Education due to heads of schools not being champions in the use of technology in educational management and pedagogy</td>
</tr>
<tr>
<td>• All heads of schools/educators trained in use of ICT</td>
<td>• Digital data in Education is available but in a disaggregated way</td>
</tr>
<tr>
<td>• New Reform agenda provides for strong support to the ICT in Education sector</td>
<td></td>
</tr>
<tr>
<td>• All primary schools are staffed with ICT Support Officers</td>
<td></td>
</tr>
<tr>
<td>• Good international partnerships with both intergovernmental and private organisations</td>
<td></td>
</tr>
<tr>
<td>• Strong policy drive for implementation of ICT in all sectors, including Education</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Good ICT infrastructure allows for potential expansion of ICT in Education system</td>
<td>• Delays in connecting schools to high speed internet</td>
</tr>
<tr>
<td>• Existing databases in Education have the potential to be expanded into EMIS</td>
<td>• Fast rate of obsolescence of mobile tools is a threat for equipment replacement</td>
</tr>
<tr>
<td>• Expansion of ICT in Education supports national growth into a services-oriented economy</td>
<td>• Relatively low number and scale of private sector operators in ICT results in issues in larger scale availability and maintenance of equipment</td>
</tr>
<tr>
<td>• Potential for further expansion of production of digital resources through the Mauritius Institute of Education</td>
<td>• Limited staff in educational institutions in the deployment and monitoring of equipment and pedagogical use of ICT in Education</td>
</tr>
<tr>
<td>• Potential for implementation of professionalized industry standard programmes in new training sectors such as Polytechnics</td>
<td></td>
</tr>
</tbody>
</table>
Recommendations for further improvement in managing ICT in education sector

*Synergy through a Strategy paper for ICT in Education*

The paper has presented that the Ministry has, in line with Government policy of providing extended learning opportunities to all students, been expanding ICT in Education in all sectors of Education. This policy for the expansion of ICT has as objective to pave the way for a strengthening of the use of ICT in Education, and provides a vision on which the country can build the Human Resource foundations for constructing a knowledge-based Mauritius of tomorrow.

There is nevertheless scope for further improvement and consolidation in the implementation of these policies. While a detailed discussion would be above the scope of this paper, a starting observation is that there is a need for a strategized and coordinated approach through the preparation of a strategy paper for ICT in Education in Mauritius. Such a synergy document could present in more details the various possibilities for further action, such as expansion of the measures under way to encompass the pre-primary sector as a key level for early adoption of ICT in Education.

*Piloting of a BYOD approach in the secondary and TVET sectors*

To ensure a stronger monitoring of the growing technical platform that is being implemented in schools, there is also a need to consolidate the staffing at technical level in the Education Zones to ensure that there is a strong technical supervisory capacity in the many projects under implementation. Consideration can also be given, in particular for piloting and testing at Secondary and Technical Education levels, regarding the adoption of a culture of Bring Your Own Device (BYOD), given the growing costs in public expenditure in infrastructure and equipment in Education.

*Setting up of a dedicated NREN*

Another proposition for implementation would be to consider the advisability and effectiveness of the development of a dedicated National Research and Education Network (NREN) that would constitute a research and education backbone connecting all educational institutions and promote sharing and information flow among schools, technical institutions and universities.

*Setting up of a National EMIS*

Mauritius would benefit in the improvement an expansion of an information in education system. Such an online system, that would be optimally functioning once connectivity is widespread in both Primary and Secondary schools, would provide student, staff and infrastructure information from school administration. The system would also need to provide for assessment follow-up, pupil enrolment, admission schedules and processes, student and teacher attendance, transfer exercises and drop out tracking.
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E-management: A journey from the databank to the modern Information System at the Université des Mascareignes

Nirmal Kumar Betchoo
Université des Mascareignes, Mauritius
nbetchoo@udm.ac.mu

Abstract

This paper analyses the development of e-management from a conceptual framework that explains how information management has transited from the traditional databank of office administration to a modernised information system. If the objective is to record, analyse, retrieve, amend and delete data, the databank, though useful even today, gets obsolete over time. With the paperless office in mind, the information system has become the most desired need for businesses today. The research explains the transition to e-administration at the Université des Mascareignes (UdM) stating that the new information system developed is of major benefit to the organisation. The research methodology uses comparative data analysis to show that modern information system has tangible benefits in improving data management with users of the information system. Downsizing the focus of the research on employee administration, the paper posits that there could be possibilities for developing cloud computing, big data and agile system of e-management to ensure the conservation of data, develop higher interconnectivity with staff, monitor staff information while creating greater flexibility in e-managing the day-to-day running of the university.

Key words: E-management, Information system, Users, University

Introduction

Organisations, particular office administration, started as paper-based work with heaps of documents and data that that to be stored in files and classified as record evidences in filing cabinets. This proved to be the core of office administration in the traditional way. There was likely to be the obsolescence of filing cabinets, binders and folders and the packed shelves as they existed in the 1970s (Compu-Stor, 2014). This tendency existed since a long time but is gradually being replaced by the modern office relying on computerised information. This is not a novelty today given that existing office employees very easily manage information in the form of communication through computers with people inside and outside the firm.

New office administration relies on the efficient and effective use of electronic information that looks to be advantageous in many ways ranging from space used and ease of access of information. Most organisations have shifted to the modern system that makes lesser use of paper documents, except for official signatures and circulation. Harrison (2013) mentioned that through emerging paperless technologies, businesses could reduce inefficiencies and reduce their environmental footprint at the same time. Although the shift from the databank to e-administration is evident nowadays, it would be reasonable to see how this transition has taken place and what was the rationale behind it. This research reviews the transition of information management from a paper-based organisation to a full-fledged e-management
at the Université des Mascareignes\(^1\) (UdM), a public tertiary institution that operates since 2012 under a university status.

**Aims and objectives of the paper**

Although e-management is described by ICI Global (2017) as the use of information technology to improve management of government by streamlining government business processes and improving the flow of information within government, this paper focuses on a public university which is part of a government body that adopts this concept in a unique way.

The paper aims firstly to draft a roadmap for e-management resulting from the transition of information management from the traditional paper work to the current computerised management of information at the UdM. Although this might look as a customary evidence of shift to a modern filing and administration system, the paper shows the uniqueness that relates to a university compared to other organisation.

There are certain objectives that the paper fulfils. These are explained as follows:

Firstly, it examines the conditions within which the UdM operating in the past as a tertiary education institution adopted the traditional paper system and used concurrently an automated filing system.

It also explains the need for the university to use the information system as a result of the relevance of using computerised data for the benefit of students and employees in the university.

Additionally, the arguments for making inroads in using cloud computing and managing big data for the long-term requirements of the UdM.

At a further level, the paper examines the benefits and drawbacks of modern e-management.

In a nutshell, the objectives are outlined in the roadmap in the use of information within the university in a progressive manner since its creation.

**A journey from the databank to the modern Information System**

It would be important to illustrate how information has been managed at the UdM since its creation up till today. This might look similar to any public organisation but, as stated above, there are some particularities that must be duly considered in the university’s context.

**The information databank**

The UdM had former appellations like the Droopnath Ramphul Polytechnic\(^2\), the Maharishi Dayanand Polytechnic and the Swami Dayanand Institute of Management (SDIM) prior to becoming a full-fledged university as from 2012. Initially, it used the compound of the former Droopnath Ramphul State Secondary School and was dependent on small offices to manage information.

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\(^1\) Université des Mascareignes, website: [www.udm.mu](http://www.udm.mu)

\(^2\) Former name of SDIM and UDM, [http://www.virtualschoolsandcolleges.eu](http://www.virtualschoolsandcolleges.eu).
As in any public sector organisation, the polytechnic used information under two classifications. The first category was information pertaining to staff and the second one, a more extensive one, focused on students’ information that was important for the institute’s records or databank. Business Dictionary (2017) defines a databank as organised collection of data or information on one or more subjects, or for a particular purpose.

Briefly, data could be categorised for both categories as follows:

**SDIM Staff:** Personal file, Academic qualifications, record of leaves—sick, local, vacation leaves, training undertaken.

Documentation of the institute, correspondences between parent ministry and institute, notes of meetings held, correspondence with Singapore Polytechnic and SDIM, documents used within the Mauritius Examinations Syndicate and the institute for examinations.

**Students:** Admission forms, student records comprising attendances, class performance and examinations, absences and leaves, discipline and suggestion documents, student letters, etc.

The information was recorded on paper in secure metal-framed filing cabinets. By using special files and data categorisation, information could be securely kept in the office. Definitely, as more information was used and circulated in office, the bulk of paper increased and the greater was the need to manage information and files.

**An integrated databank**

Along with the databank, it is worth mentioning the integrated form of information management in the SDIM in the early stages of its development. A flow chart explains the interaction of various systems within the organisation.

![Flow chart of data management](image)

**Figure 1: Basic data management at the SDIM during 1995-2000**

As seen from the figure provided, information was essentially paper-based in the university with the stores as the main source of provider of logistics in the form of paper and various office documents. These impacted directly photocopying services which were much of a need at the beginning in parallel with the documentation and processing services that were undertaken by clerical staff of the institution. Data was ultimately stored in two categories, namely personal files both for staff and students.
Basic role of office administration

From this standpoint, it is important to briefly address the basic roles of office administration at the ex-SDIM (now UdM).

Recording information

Information was recorded from the two main providers at the UdM, namely students and administration and teaching staff. This information was compiled on personal files for each category with subdivisions like personal staff file, training followed, notes of meeting, students’ file, performance, copies of certificates, application forms.

Analysis and processing of data

Data analysis and processing were the main activities undertaken by administrative staff. These were also the activity of teaching staff dealing with entries of marks, correspondences with external moderators from Singapore and TAFE Western Australia, reports written in Advisory Committees of the institution.

Upgrading information

Information upgrade could be in the form of the changes brought in terms of students’ progress in the institution, additional qualifications like Masters degrees earned by UdM staff along with an upgrade of professional development in terms of new training competences earned by academic and non-academic staff.

Retrieving information

Information retrieval is of importance when management has to check information on students or academic staff regarding training and learning opportunities. Some information could be circulated in the office for personal use by staff. It is noted that confidentiality was duly respected in such an activity.

Amending and deleting redundant data

To have a suitable record of data, certain information could be considered as redundant like duplication of data, copies of letters circulated in office, data regarding students or staff who left the institute in the early years of operation. Employees could maintain and update filing, mailing and database systems either manually or using a computer (Careerplanner.com, 2017)

From databank to database

An important transition took place as from Year 2000 onwards with the implementation of computers in the Mauritian society. Although personal computers were the main logistics available with Windows 95 software, management of the institution started to vulgarise the use of information processed through computers. Windows 95 was a 32-bit operating system with built-in connectivity support to provide high performance, robustness, and complete backward compatibility (Microsoft, 2017). This was a first step in moving from the databank to the database. Although the concept was widely approved by most of the staff, there were reservations as to the validity of using computerised data compared to official letterhead documents that were widely used in office.

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3 Singapore Polytechnic (1995) and TAFE Western Australia (1997-2010) partnered with the ex-SDIM.
There was also the reluctance concept regarding change. Academic staff and Information Technology technicians were the best at using and manipulating computerised data while other staff were still much limited to using such type of information. There was evidence of technical training provided to all staff although the progress could be considered as laborious at the beginning.

*Transition concepts from databank to database*

The second stage of development came from moving from the databank to the database concept. A mainframe under the control of a data administrator was installed in the computer laboratory of the UdM as from year 2000. The objective was to firstly provide internet connectivity to all staff including students. All the incumbents were provided with a password to access information on the net.

Apart from that, an intranet service was also developed whereby lecturers could send lecture notes, handouts including marked scripts to students.

Regarding academic and non-academic staff, the mainframe was an opportunity to store data and also allow for administration to gradually transform databank into database. Paper documents could be scanned while other information could be input on prescribed forms.

The chart below illustrates the function of the database system developed by UdM.

![Database Management Diagram](image)

Figure 2: Database management at the SDIM from 2000 onwards

The main concern for the database was that the mainframe could support data from some 30 administrative staff, 20 lecturers and around 400 students on-campus. At the start, this was possible while inherent risks in the system like viruses, worms, hacking, etc. could lead to several crash of the system and prompt administration to continue making the use of the databank. Very often, situations of contingency management of the system was required.

*A digitalised concept of information management*

Since the creation of the Université des Mascareignes in 2012 and a higher need for data conservation and management, funding was obtained to update the existing system in the university. There have been certain developments to state how new pathways were
developed to ensure that the university becomes more independent and customised to using information. Certain decisive steps are developed below.

**Creation of university personalised account**

A major development occurred through the development of personalised user staff accounts. This brought a higher level of security for all staff to manage their accounts as well as eliminating junk or unwanted mails which are possible in ordinary accounts.

**Development of Outlook**

Microsoft Outlook was developed as the platform that would be used by all staff. This could allow faster and more effective exchange of information. Additionally, communication could be enhanced by sending information both to individual and numerous recipients.

**Full communication online**

Paper documents were less used as from 2013 except for highly important information. All users communicated fully on all issues pertaining to the university. It was also an effective way to connect various recipients like usher, administration and students regarding any decision taken on an adhoc basis.

**Management of information on database**

Since the database came into operation, the conversion of information from paper to the database became more evident. For example, quality procedures under the Quality Assurance of the UdM were made available online to all interested parties.

**Upgrading of information system at the UdM**

The system was also upgraded with added capacity and new mainframes provided by IBM Mauritius under licence. This could allow for big data to be stored and managed in the system.

**Back-up services of the system**

Backing-up of the database was an imperative taking into consideration that the initial mainframe was vulnerable to crash, viruses and that too often, information had to be retrieved to avoid data loss. In the modern system, information was not only stored in one location but backed up in the main office in Rose Hill campus.

**A new era of information management**

The journey to digitalisation and e-management could be now entrenched in the following scenario. Since the creation of the university, there have been deeper thoughts on harnessing the use of information technology at work. This comes from the fact that there is a higher need to use e-services for the benefit of all users at the UdM. At the same time, it would be useful to think of upcoming needs of the university.

**Use of big data**

A greater need to have a modern database is the consideration for the use of big data. According to SAS Institute (2017), big data can be analysed for insights that lead to better decisions and strategic business moves. This could help research people undertake multivariate and longitudinal analysis of information. The term is considered as a buzz but
the use of big data will ultimately depend on the capacity of servers to provide suitable space for such data.

**Moving to Linux and virus free systems**

A recent expert working as visiting professor at the UdM claimed that the university already goes through major expenditure on using licensed Microsoft software that costs a lot to the institution including the renewal of licences, software and hardware. He claims that a move to Linux might be a cost-saving effort but equally serve in better harnessing the use of data and information. Wallen (2010) stated that given the open nature of Linux, the risks of virus infection remain low in such a system.

**Harnessing the use of cloud computing**

Cloud computing is a key element to consider in the existing database of the UdM. The advantage that cloud computing offers is that companies use a resource like a virtual machine or an application as a utility rather than building and maintaining computer infrastructure in house (Techtarget, 2017). Using a platform that allows for virtual storage of information in terabyte terms, cloud computing is also welcome as a back-up system which allows the retrieving and use of data in a less cumbersome way than information stored on hard disk.

**Envisaging an e-campus**

The e-campus concept is also an integral part of database management. It should apply to both students and the employees of the university.

**Students**

Regarding students, e-learning is being considered although it has not yet been experimented at the UdM. To some extent, development of a platform similar to Moodle would be a much better choice compared to the existing intranet given that there is the possibility of better managing online courses, examinations and interactive engagement of the student with the lecturer.

**UdM employees**

Regarding employees, the e-campus could not only be a means of managing employee data but also ensure how employees could themselves better use the system. For instance, data management by employees might also be coordinated by managers to constantly update data on attendance, leaves, grants, etc. It might be also possible to accommodate the financial department and better address employee records. The latter might be a sensitive issue with regards to the confidentiality of information.

**Research Findings—An assessment of e-management on a point rating scale**

If the journey that illustrated the migration of information management from the databank to a modernised database, there are arguments that are worth considering regarding the perception of the staff on e-management. A Likert scale on 4 Points—Least Agree 1 to Most Agree 4—was proposed to all categories of employees in the university only at Pamplemousses Campus. This comprised 5 respondents from administrative staff, 15 from academic staff and 30 from students as users of the system. Questions were separately asked to the users as their objectives behind using the information system differed. 10 questions were asked to both audiences: UdM staff and students.
**e-Management form for UdM staff with 20 respondents:**

Table 1: Response of UdM staff on e-management

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel conversant on using computers at work.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>15</td>
<td>3</td>
<td>3.00</td>
</tr>
<tr>
<td>I communicate well with my colleagues.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>1</td>
<td>2.85</td>
</tr>
<tr>
<td>I share information with colleagues in the university.</td>
<td></td>
<td>1</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>2.85</td>
</tr>
<tr>
<td>I manage my data reasonably.</td>
<td></td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>2.55</td>
</tr>
<tr>
<td>I am aware of data loss.</td>
<td></td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>2.40</td>
</tr>
<tr>
<td>I am given support on working with new systems.</td>
<td></td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>2.25</td>
</tr>
<tr>
<td>There is enough training when I use a new system.</td>
<td></td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>2.45</td>
</tr>
<tr>
<td>There is good follow-up on training me with new systems.</td>
<td></td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>2.15</td>
</tr>
<tr>
<td>I am encouraged to communicate under e-management.</td>
<td></td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>2.65</td>
</tr>
<tr>
<td>I find adequate feedback with regards to e-management.</td>
<td></td>
<td>3</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>2.60</td>
</tr>
</tbody>
</table>

The mean average is 2.57. The standard deviation is 0.27 and the variance is 0.07. The general observation is that e-management at the UdM for staff is rated fair higher than the mean value 2. Strong areas noted are: the use of computers, communication, sharing of data and feedback. Weaker areas could be training, support and follow-up.

**e-Management form for students with 30 respondents:**

Table 2: Response of UdM students on e-management

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel conversant on using computers at work.</td>
<td></td>
<td>2</td>
<td>3</td>
<td>22</td>
<td>3</td>
<td>2.86</td>
</tr>
<tr>
<td>I communicate well with my lecturers.</td>
<td></td>
<td>5</td>
<td>8</td>
<td>15</td>
<td>2</td>
<td>2.46</td>
</tr>
<tr>
<td>I respond reasonably with my lecturers.</td>
<td></td>
<td>5</td>
<td>6</td>
<td>15</td>
<td>4</td>
<td>2.60</td>
</tr>
<tr>
<td>I find suitable interactivity on using computers.</td>
<td></td>
<td>4</td>
<td>6</td>
<td>14</td>
<td>6</td>
<td>2.73</td>
</tr>
<tr>
<td>I am aware of data loss.</td>
<td></td>
<td>8</td>
<td>4</td>
<td>12</td>
<td>6</td>
<td>2.53</td>
</tr>
<tr>
<td>There is suitable administration of antivirus to the system.</td>
<td></td>
<td>10</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>2.26</td>
</tr>
<tr>
<td>Internet connection and Wi-Fi is available.</td>
<td></td>
<td>8</td>
<td>13</td>
<td>8</td>
<td>1</td>
<td>2.03</td>
</tr>
<tr>
<td>Educational tools are adequately provided.</td>
<td></td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>5</td>
<td>2.46</td>
</tr>
<tr>
<td>Educational information is updated in the system.</td>
<td></td>
<td>12</td>
<td>7</td>
<td>9</td>
<td>2</td>
<td>2.03</td>
</tr>
<tr>
<td>I can anticipate the future of e-learning at the UdM.</td>
<td></td>
<td>2</td>
<td>8</td>
<td>12</td>
<td>8</td>
<td>2.87</td>
</tr>
</tbody>
</table>

The mean average is 2.48. The standard deviation is 0.3 and the variance is 0.09. A first observation makes it clear that students are quite satisfied with e-management opportunities with strong scores on using computers, responding to lecturers, interactivity, e-learning. Weaker areas are a little more evident here namely Internet and Wi-Fi connection, updating information to the system.
Recommendations

As evidenced from the information gathered both from UdM staff and students who are users of the e-management system, certain suggestions would be useful. Firstly, the weaker areas need to be considered to ensure better use of e-management. For instance, there could be questions regarding the support that UdM staff need to be provided with training. Since software changes occasionally, it is essential to provide the right form of training especially in a situation of change from a previous to a new version. Training on new e-platforms is a must and cannot be ignored. Evidently, this might better apply to educated and qualified personnel like academics and lesser to staff from other areas like general administration. The positive points like the conversance of using computers, sharing information, engaging in discussion and feedback need to be consolidated since these will foster better e-management.

Regarding students who also form part of e-management, Internet connectivity should be improved including the upload of educational information. It is noted that platforms like Moodle are quite good at managing student information and progress. In Moodle, a teacher has responsibility for the materials in his own course (Moodle. 2017). Similar platforms tailor-made by the UdM could also integrate student attendance, performance and progress. This option was sought earlier but is still under consideration.

Upcoming Issues on e-management

From the findings, certain upcoming issues need to be developed regarding the position of the UdM regarding the development of e-management. There is growing concern on better addressing this issue on the following points. These are highlighted in sub-paragraphs.

Operation use of e-management system

Better usage of information

Information use is the main consideration under e-management at UdM. Not only e-mails would matter but a variety of documents which could be made available to staff. This depends on the development of the website with greater navigation opportunities offered to users to have access to a variety of data.

Better user interface

User interface is necessary for better feedback and interaction. Evidently, this might require the use of a systems administrator and a secretary capable of handling queries from different users. Possibly, because of the university’s scope of operations, this is not needed but remains useful at certain peak times of operation.

Better monitoring of e-management

Employee monitoring could be improved under e-management. Quick access to employee records, management of attendances, leaves but also performance could be envisaged. Considering monitoring, there is also the need to see that the system is not hacked and any suspicious operation should be deterred.

Cost-benefit use of the system

From the investment envisaged with e-management, it is also important to see how the system works profitably and how overheads might be reduced. Certainly, a much dependency
on consumables would be offset by a more pronounced usage of data in the system. Davies (2015) mentioned that ‘digital by default’ has the effect of increasing cost savings. Services claimed as ‘digital by default’ are designed in such a way that they entice users to use them without trouble.

**Technical use of e-management system**

**Stronger storage capacity**

From the technical side, it is essential to have greater storage capacity. This is also being developed by integrating higher capacity hardware like IBM mainframe installations in the computer labs. This must be constantly updated to see that greater volume of data might be stored and used in the future.

**Improved Connectivity and interaction**

Electricity shortcuts are a major source of problem at UdM, Pamplemousses. Along with this issue, Internet connectivity needs to revamped to ensure full connectivity during the operation of the university. Wi-Fi connections need to be improved for the benefit of students and staff.

**Cloud computing**

Cloud computing is being initiated while there is the need to develop it fully. Cloud computing offers the prospect of reducing the costs of ICTs through economies of scale between 10 and 30% (Leimbach, 2011). This enables greater interaction among users while allowing users the possibility of keeping large volumes of information online with a lowered risk of complete data loss.

**Big data**

Big data computing is gaining foothold in the computer world but is also more of a necessity at the university level. It is sought that such data will ensure greater availability of information and utilisation in research and development.

**Agile systems**

Though it is easy to speak of agile computer systems, it is difficult to envisage it in a concrete way. Firstly, the importance of system back-up needs to be reinforced along with the resilience from the information system in case of threats like hacking or system failure. This should also be in line with the use of data by numerous users without delay in gaining and processing information. A suitable example might be the Resilient File System that works with storage spaces creating a pool of hardware and virtual storage devices while at the same time, protecting data (Techtarget, 2017).

**Conclusion**

This research considered the evolution of e-management in a chronological way starting from the traditional databank and moving to a computerised system and a modernised e-management system over the years. The fact that the institution is a university should make it possible for better e-management that concerns the involvement of each and every member concerned. Since the Government of Mauritius is enabling better use of computer infrastructure, there should be a leap from current data usage to a more comprehensive use
of information. It is in the Mauritian government policy to have the skilled manpower to transform the national landscape of the country (ICTA, 2014). This should help in the development of modern e-management where the ownership is in the hands of the Université des Mascareignes but there is also shared usage of information for any purpose. The fact that more data will be used for research and development, programming and storage makes it clear that e-management will have to accommodate a greater number of concerns and see that the e-concept emerges in the form of intensive but cautious use of information in the years to come.

References

The Use of Social Customer Relationship Management for Optimising Business Performance in the Hotel Industry in Mauritius.

Senika Dewnarain
Open University of Mauritius, Mauritius
senika.dewnarain@telfair.ac.mu

Abstract

While social media marketing and more particularly social commerce, are trending topics in the hospitality industry worldwide, it is worth noting that there is a dearth in literature available on social media practices in small island development states. Therefore, the aim of this paper is to examine how hotels in Mauritius are using different social media platforms as a source of competitive advantage to attract and retain customers. A case study approach was used and 7 GMs from 5 major local hotel chains have been interviewed in order to understand the perception of hospitality leaders on the use of social media tools for customer relationship management. The sample population only consisted of GMs from 3 star, 4 star and 5 star hotel properties and in-depth interviews were used in order to gain data sets that were used to develop this empirical paper. The findings of this research indicate that the current business model of hotels and the management style of the GM, are key factors influencing the strategic use of social media platforms.

Keywords: social media, social customer relationship management, relationship marketing, hotel industry, Mauritius, competitive advantage

Introduction

Traditional Customer Relationship Management systems used to provide companies with limited insight on customers as they dealt mostly with behavioural knowledge such as what products were purchased and customer service issues (Greenberg 2010). CRM systems stored transactional data that were mainly used for cross-selling or upselling products and services. By contrast, CRM 2.0 which is commonly known as social customer relationship management (SCRM), focuses on the interactive aspect of social media, community involvement and relational exchanges through the process of co-creation of value whereby the customer becomes an integral part of either product development or service delivery. According to Woodcock et al. (2011), SCRM lowers the barriers to engagement and enables influential nodes at various stages of the communication process and it further decreases customer related cost.

Rationale for research and aim

Even with the current hype around social media tools, the effectiveness of SCRM remains unexplored to a large extent and companies are mainly experimenting with social media applications implementations without really understanding how SCRM can contribute to customer satisfaction and loyalty (Trainor et al., 2014). Previous qualitative research conducted by Bull in 2003, in a manufacturing firm in the UK, has indicated that the successful implementation of CRM would require effective leadership, sourcing, targeting and evaluation strategies. However, there is limited research on the integration of social media tools to build
meaningful customer relationship in service –based firms in a small island developing state and therefore, the aim of this paper is to examine how hotels in Mauritius are using different social media platforms as a source of competitive advantage to attract and retain customers.

Literature Review

Customer Relationship Management

CRM is often viewed as the deployment of customer related information or knowledge to deliver relevant products or services to customers with an aim of improving customer loyalty, through the effective management of relationship (Bull 2003; Levine 2000). CRM differs from traditional relationship marketing as it involves the use of technology such as information from the database system in order to facilitate relationship with the client (Charoensukmongkol and Sasatanun, 2017). Viewed from another perspective, Payne and Frow (2005, p.168) defined CRM broadly and strategically as a “holistic approach to managing customer relationships to create shareholder value” rather than a series of technological solutions. This definition underscores the significance of CRM strategy as it firstly identifies the right customers and then establishes customer knowledge about products and solutions based on interactions across various communication channels. The following section will further elaborate on CRM strategy effectiveness in creating a sustainable competitive advantage.

CRM strategy

According to Strauss and Frost (2014; Charoensukmongkol and Sasatanun, 2017), some marketers believe that it is crucial to build bonds that transcend product experience, with target audiences. As shown in table 1.0 below, there are 3 different levels of relationship and a successful bond is obtained firstly if the product or service satisfies the buyer and secondly, if all the 3 levels of relationship marketing are used. At level 1, which has the lowest potential for sustained competitive advantage; businesses build a financial bond with purchasers by using pricing strategies. Since promotional pricing can be easily imitated by competitors, financial bond is classified as the lowest level of relationship marketing (Strauss and Frost, 2014). The next level focuses on one to one communication between firm and its customers as well as peer to peer communication that has been made possible by Web 2.0 technologies and it is known as the social bond. Social media channels promote level-two relationship by encouraging users to have conversations with other customers or businesses online and this somehow contributes to the strengthening of brand loyalty.

However, organizations should aim to forge structural bonds which is the highest level of relationship, by making structural changes such as features and content that add value to customer’s experience (Strauss and Frost, 2014 p.435, Venkatesan 2017). Even though, there is an array of social media applications available for users, customers are selective in their choice and register on very specific ones. Once customers form part of an online community and they invest their time customizing their user interface; they will be reluctant to switch to another platform given the affordances. TripAdvisor is a key example of a company that has this structural bond through content engagement. As soon as travel consumers register on this platform, they have instant access to a large pool of information which in turn ease evaluation of alternatives and reduces the time taken in the decision-making process.
(O’Connor 2008). Marketers are no longer responsible for producing or presenting contents online on Trip Advisor since customers take ownership of producing content online based on their personal experience. Similarly, it is worth noting that social networking sites such as Facebook and LinkedIn combine level 2 and level 3. Therefore, the use of social networking sites can augment the potential for sustained competitive advantage for hotels by enabling them to establish both social and structural bonds with their customers.

<table>
<thead>
<tr>
<th>Level</th>
<th>Primary Bond</th>
<th>Potential for Sustained Competitive Advantage</th>
<th>Main Element of Marketing Mix</th>
<th>Web Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Financial</td>
<td>Low</td>
<td>Price</td>
<td>Southwest.com Easyjet.com</td>
</tr>
<tr>
<td>Two</td>
<td>Social</td>
<td>Build 1:1 relationships</td>
<td>Medium Personal communications</td>
<td>Facebook.com LinkedIn.com</td>
</tr>
<tr>
<td>Four</td>
<td>Structural</td>
<td>High</td>
<td>Service delivery Customisable features</td>
<td>TripAdvisor Facebook.com LinkedIn.com</td>
</tr>
</tbody>
</table>

**Hotel industry in Mauritius**

According to an International Travel and Tourism report, there are 116 hotels licensed hotels in Mauritius and as at end of June 2016, 111 of them were in operation while the remaining 5 hotels were closed for renovation (Gooraya-Pologadoo 2016). Moreover, a hotel is classified as a large hotel when its capacity exceeds 80 rooms. There are currently 54 large hotels in Mauritius and these hotels represent 49% of the licensed 111 hotels in operations but make up 76% of total room capacity and 77% of total bed places in Mauritius. These figures indicate that 49% of hotels in Mauritius account for most of the number of room night sold to tourists. As suggested by Mr. Kevin Ramkaloan, the Director of Mauritius Tourism Promotion Authority (MTPA), with an anticipated growth in the number of tourists from India and China, hotel room revenue is likely to expand at a 10.6% compound annual rate to € 920 million (Rs 36.4 billion) in 2020 (PWC report 2016, cited in News on Sunday 2016).

**Social media use for CRM**

CRM within the context of the hospitality industry in Mauritius is often associated with information and communication technology (ICT) tools and not necessarily, business or marketing strategy (Oogarah 2012). Therefore, investing on CRM technology does not mean value creation and this is the major reason behind the failure of most CRM projects. Businesses need to set the right goals and performance metrics that is a robust CRM strategy should be designed. Hotels in Mauritius are operating in a highly competitive market and if they do not focus on growing their customer portfolio by using social media tools such as Facebook and Instagram that have become emerging trends in facilitating CRM, they will lose out on revenue in the long run.
Methodology

The aim of this paper is to examine how hotels in Mauritius are using different social media platforms as a source of competitive advantage. Accordingly, 7 GMs from 5 major local hotel chains have been interviewed in order to understand the perception of hospitality leaders on social media marketing strategies used by their respective hotels. As rightly stated by Patton (1990, p.184), “there are no rules for sample size in qualitative inquiry” and sample size entirely depends on the purpose of the study, access to resources and availability of time to conduct research. By contrast, Lincoln and Guba (1985, p. 202) mentioned that sample selection should be done to the point of redundancy that is when information saturation takes place and new themes are no longer emerging. Hence, purposive sampling was used and the sample population only consisted of GMs from 3 star, 4 star and 5 star hotel properties and semi-structured in-depth interviews were used in order to gain data sets to develop this empirical paper. It is worth noting that a purposive sampling strategy was deemed appropriate for this research as only GMs from local Mauritian hotel chains were invited to participate in this research in order to understand their perspectives on the changing marketing communication landscape in Mauritius.

A case study approach

According to Yin(2009, p.2), case studies are the preferred method when “(a) “how” and “why” questions are being posed, (b) the investigator has little control over events and c)the focus in on a contemporary phenomenon within a real-life context.” Case studies are often used to study organizational and managerial processes as it enables researchers to study complex social phenomena and to retain meaningful characteristics of real-life events. For instance, in this paper, a case study approach was used to see how GMs of Mauritian hotel chains perceive the implementation of SCRM strategy. Therefore, 7 GMs, from the 5 largest Mauritian hotel chains, who had “a deep and insightful understanding of collective action in context” were included in this research (Doz 2011, 585). The 5 major Mauritian hotel chains selected contribute a significant amount of revenue to the overall economy of the country and were hence considered relevant for this study. Moreover, the cases were chosen from a population of 116 licensed hotels and were purposefully selected to capture diversity in terms of hotel classification, category and geographic location.

For the purpose of this study, face-to-face interviews were conducted with a sample of 7 highly committed General Managers who were very passionate about their jobs and willingly shared their stories and experiences with the researcher. All the interviews were conducted personally by the researcher, at the respective hotels and the interviews were recorded using a voice recorder. At the beginning of each interview, each interviewee was provided with a questionnaire and a consent form. Furthermore, the participants were informed that data will be collected anonymously and the identity of the interviewee will never be disclosed at any time.

Data Analysis

According to Creswell (2013), in qualitative research, data analysis goes concurrently with data collection and write-up of findings. Therefore, data analysis was done after the very first interview and this in turn provided the researcher with some insights on the relevance of the
research questions. Unlike quantitative research whereby the researcher endeavours to preserve all of the data collected in order to reconstruct or substitute missing data, in qualitative research data reduction takes place and at the end, the researcher is left with around five to seven themes (Guest et al., 2012). Given the richness of data in qualitative research, all the data cannot be used. Hence, during the process of data analysis, codification first takes place and then codes are linked together to form a few selective emerging themes (Creswell 2013). While the most popular software for qualitative data analysis remains MAXqda, Atlas.ti and QSR NVivo (Guest et al. 2012), due to time constraint, hand-coding was used for the purpose of this study.

Findings

Following the thematic analysis, several interesting themes emerged. The GMs spoke lengthily about the various benefits and challenges faced by local hotel chains when using social networking sites and Trip Advisor for managing customer relationships. However, the focus of this paper is on strategic level decision-making. Therefore, for the purpose of this study, only two key themes that align with the objective of this paper will be discussed. Firstly, the author will elaborate on the business model of hotels in Mauritius and then, the GMs perception of using social media as part of their customer relationship marketing strategy will be discussed.

Business Model

The level of integration of social media platforms in the process of customer relationship management varies from inexperienced through experienced to expert when it comes to the hotel industry in Mauritius. While certain hotels are at the conceptual stage, other hotels are highly experienced when it comes to using social media to boost brand awareness and to consolidate their relationship with customers through real-time communication. Social media marketing policies are set by the headquarters. However, every hotel unit has a certain degree of flexibility when it comes to implementation.

In several cases, social media platforms are still considered as a communication tool or to generate awareness on sales promotion but at the same time, leaders do concede that social commerce will be the next step for this sector. The main reason behind a slow transition to online platforms for sales or new customer acquisition lies in the current business model used by hoteliers. Presently, the majority of sales is generated through tour operators and the second best channel is online travel agencies such as Expedia and booking.com. Therefore, hoteliers tend to spend more time on building relationships with tour operators who are likely to send an important number of bookings as opposed to social media channels that are likely to generate a few number of direct bookings. Therefore, it can be said that the full potential of social media platforms has not been fully tapped or exploited.

GMs perception of SCRM

All the GMs unanimously agreed that TripAdvisor is a vital tool for hotel businesses and one possible explanation behind this could be the fact that Tour operators rely on the overall TripAdvisor rating prior to recommending hotels to clients. Therefore, the ranking on TripAdvisor matters as it is a key determinant that drives sales of hotel packages. GMs personally go through all the posts and comments on Trip Advisor and in most cases, they like to reply back to the clients and most importantly, they like to thank the clients for their feedback. As
discussed earlier in the literature review section, TripAdvisor brings in level 3 marketing which is a rather positive thing for hotels. As for social networking sites, the management style of the GM and personal factors such as age, education, level of user experience when it comes to social media platforms; altogether influence the extent to which social media platforms are being used to build a relationship with customers at the pre-purchase, during purchase/consumption or at the post-purchase stage.

During data collection, it was observed that newly appointed GMs or younger GMs were mostly for investing resources on managing their social media marketing strategies as compared to those who are about to retire and still believe in traditional customer relationship management. Additionally, it was noted that GMs who have recently completed an MBA or are in the process of completing one are more motivated to implement a SCRM strategy in order to boost direct sales as they are conscious that the share of business from direct bookings will also take off and will represent a bigger share of the overall booking. They believe that the future lies in direct bookings even if the traditional business model will continue to exist. Conclusively, all GMs are forward thinkers and they strongly believe in a brighter future for the hotel industry. However, one of the key dilemmas that they are often confronted with is whether to invest their resources on social media training or to prioritise service training.

Conclusion

If Mauritius wants to establish itself as a pioneer in the hospitality sector in the region, it is crucial for hoteliers to set specific objectives prior to investing on CRM software or setting up social media accounts. Setting the right objectives requires a multiple stakeholder approach and may involve employees, partners, business customers or consumers and necessitates “targeting, acquiring , retaining and growing specified relationships” ( Strauss and Frost 2014, p.434). In accordance with the previous, it can be said that numerous CRM goals are aligned with customer loyalty and if hotels wish to enhance their business performance, they need to clearly outline the Key Performance Indicators and metrics. If we refer to the affordances of Web 2.0 technologies, many companies are happy when they generate likes from customers or users share a photo holding a cocktail on the beach or having dinner at the hotel or garnering comments based on sales promotional offer posted. But having a like, a mention in a post or being tagged online, is certainly not enough to create a competitive advantage.

Based on the 3 levels of relationship marketing theory discussed earlier in the literature review, establishing structural and social bonds that form superior level relationship and enhanced business performance, can undeniably take hotels to another level of competition with international brands (Strauss and Frost 2014; Liang and Turban 2011; Charoensukmongkol and Sasatanun, 2017). Finally, when it comes to technological innovation, we cannot afford to have transactional leaders who will simply follow system and procedures. We need to have transformational leaders who believe in social commerce and will thus make room for creativity and will value storytellers and out of the box thinkers which in turn will directly influence the business performance in the future.

Acknowledgment

I would like to dedicate this paper to my parents, my sister Gyanee, little Prisha, Christel and Shubashni. Without their unflinching support, this paper would not have been possible. I would also like to thank all the GMs who took time out of their busy schedules for my
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References


Exploring the Barriers and Challenges That Limit the Uptake of the Internet of Things (IoT) in South African Retail Businesses

Nomusa Nomhle Dlamini, Kevin Johnston
University of Cape Town, South Africa
dlmnom036@myuct.ac.za; kevin.johnston@uct.ac.za

Abstract
The use of Internet of Things (IoT) is ever-increasing among businesses and individuals. Businesses that are not geared to invest in IoT in the coming years are said to be at a disadvantage, as IoT is set to have a positive and noticeable impact in retail businesses, whether big or small. In South Africa, key technology investors in retail businesses are being persuaded to invest in IoT for future growth within their businesses. However, the number of businesses that have invested in IoT to date is low due to barriers and challenges that exist in South Africa. The purpose of this paper is to present the barriers and challenges that limit the uptake of the IoT in South African retail businesses.

This research assumed an interpretivist view of reality, employing qualitative research methods to collect data, primarily through semi-structured interviews with Heads of Information Technology (IT) and C-Level IT Specialists within South African retail businesses. The research used the Technology Organisation Environment (TOE) framework as a lens to explore the barriers and challenges that limit the uptake of the IoT in South African retail businesses.

Findings revealed that retail businesses in South Africa are looking at investing in IoT in the next 2 – 3 years. However, the major barrier at present is cost; secondly to this, IoT devices are not currently widely available in South Africa. Furthermore, bandwidth is seen as a major potential barrier. Bandwidth in South Africa remains a challenge, falling below the average international rankings and therefore, limiting the uptake of the latest technology. The findings support that the intent of businesses to invest in IoT is determined by the technological context, the organisational context and the environmental context. Finally, future directions and expectations are presented and conclusions are drawn.

Keywords: Internet of Things, Retail Businesses, Barriers, Challenges, South Africa.

Introduction
“The Internet of Things (IoT), also called the Internet of Everything or the Industrial Internet, is a new technology paradigm envisioned as a global network of machines and devices capable of interacting with each other” (Lee & Lee, 2015, p. 431). The IoT is said to have been established in 1999 by Kevin Ashton, but the enabling technologies have been available years before. The IoT offers a connection of things. This can include humans, tags, sensors, over the internet. The IoT aims to provide its users with information of the environment in which they exist to understand and control it (Díaz, et al., 2016). There are various devices that make up the IoT, these include Wireless Sensor Networks (WSNs), Radio Frequency Identifier (RFID) tags, Cloud Services, Machine-to-Machine interfaces (M2M), among others. The IoT powers multiple application domains such as automotive, healthcare, logistics, retail, to name a few. (Roman, et al., 2013).
Roman, et al. (2013) further stated that the IoT is not a single technology, but different devices that communicate to achieve different results in different application domains. “From a logical point of viewpoint, an IoT system can be depicted as a collection of smart devices that interact on a collaborative basis to fulfil a common goal. At the technological floor, IoT deployments may adopt different processing and communication architectures, technologies, and design methodologies, based on their target” (Sicari, et al., 2015, p. 146).

The use of the IoT has increased in recent years, more so in the last decade due to escalation and proliferation of wireless communication systems which serve as the backbone of interconnectedness in the IoT (Sicari, et al., 2015). The escalation and proliferation of wireless communication systems is set to create a new cognitive environment, where people do not use the Internet or wireless communication systems solely for browsing the Web, sending and receiving emails or using social networks, but creating a space where people communicate with smart objects forming a pervasive computing environment (Miorandi, et al., 2012).

Babar, Stango, Prasad, Sen and Prasad (2011) stated that the IoT is set to make the lives of its users easier by creating a digital environment that is sensitive, adaptive and responsive. However, though technologies like the IoT offer opportunities to its users, it also presents various challenges, limiting its uptake (Chen, 2012). The purpose of this paper is to explore the barriers and challenges that limit the uptake of the internet of things (IoT) in South African retail businesses.

The paper is presented in 6 sections. The following section will discuss the Literature Review which aims to provide a brief background to the topic and the Theoretical Framework used for this research. Section 3 outlines the Research Method. Section 4 presents the results of the research, section 5 presents the future directions and expectations and lastly conclusions are drawn in Chapter 6.

The main questions and sub-questions of the research are as follows:

**Main Research Question**

- “What are the challenges and potential challenges of using IoT in South African retail businesses?”

**Sub Questions**

- “What technological challenges will IoT pose in South African retail businesses?”
- “What organisational challenges will IoT pose in South African retail businesses?”
- “What challenges will the South African retail environment have when using IoT?”

**Literature Review**

The use of connected devices, particularly in the IoT realm has changed the way customers in the retail environment live, work and play reshaping the retail industry. Retail businesses are using intelligent, connected devices to improve customers’ instore experiences, creating new markets and opportunities for retailers (Gregory, 2015). The IoT promises retailers a paradigm where digital sensing, communication and processing will be connected to daily processes creating a ubiquitous environment where devices and things collect information and data about their surroundings in real time (Chen, 2012). The connection of customers and the IoT
is through 50 billion different devices and things such as smartphones, wearables, laptops or sensors that offer a connection through the internet (Yaqoob, et al., 2017).

Processes in the retail environment that use the IoT include, but are not limited to, contactless checkouts, smart mirrors, smart shopping carts, smart price tags, smart thermostats, RFID tracking of inventory, smart shelves, smart packaging (Gregory, 2015). These processes are seen to be evident in some retail stores such as Amazon Go which offers contactless checkouts through the store mobile application. Technologies embedded in this realm include computer vision, sensor fusion and deep learning creating a “Just Walk Out Technology” where customers are charged on their Amazon account when they walk out of the store creating efficiencies for the retailer and customer (Amazon, 2017).

According to Chen (2012) the IoT offers new possibilities that were not previously available to users. Benefits of the IoT include real time data, real time tracking, cheaper energy and production, remote working and increases in productivity levels (Johansson, 2016). Lee and Lee (2015) stated that Gartner (2014) predicted that by the year 2020 there will be 26 billion connected things and devices exceeding the 0.9 billion mark in 2009, increasing the availability of information for retailers also changing the supply chain environment. However, “this paradigm shift creates numerous challenges and opportunities…” (Chen, 2012, p. 384).

**Barriers and Challenges**

This section explores the barriers and challenges in the IoT:

Security and privacy remain the core challenges in the IoT (Diaz, et al., 2016).

**Security**

Security challenges in the IoT emanate from the “lack of transport encryption, insecure Web interfaces, inadequate software protection, and insufficient authorisation” (Lee & Lee, 2015, p. 439). Further security challenges include Denial of Service (DoS), Physical Damage, Eavesdropping, Node Capture, and Controlling (Roman, et al., 2013). Security in the IoT is a challenge due to the number of connected devices. However, the success of the IoT will depend on overcoming this challenge (Roman, et al., 2013). Sicari, et al. (2015) stated that authentication, confidentiality and access control can be used to overcome the security challenges. Figure 1 illustrates some of the challenges in the IoT (Miorandi, et al., 2012).
Privacy

"Privacy defines the rules under which data referring to individual users may be accessed" (Miorandi, et al., 2012, p. 1507) The IoT generates large amounts of data about its users such as location, movements and purchasing preferences which increases privacy concerns (Lee & Lee, 2015). Users of the IoT require basic protection of their personal information on their activities (Sicari, et al., 2015). Privacy in the IoT is important because, as security, it determines the success of the use of IoT (Miorandi, et al., 2012). However, a survey by TRUSTe indicated that 22% of internet users believe that the benefits of smart devices eliminate the privacy concerns (Lee & Lee, 2015).

Trust and Governance

"The size and heterogeneity of the IoT also affects its trust and governance" (Roman, et al., 2013, p. 2271). Sicari, et al. (2015) stated that trust does not have one meaning as it means different things to different individuals, however, the importance of trust holds the same meaning to everyone. Miorandi, et al. (2012) argued that there are various issues with the computation of IoT to develop trust services. This will start from defining what trust is in the IoT to ensure security and privacy in its use (Miorandi, et al., 2012). Furthermore, governance is also an important aspect in the IoT which links to its trust. Due to the proliferation of devices and things in the IoT, governance can be seen as an enabler ensuring that devices work the way they are meant to creating a stable environment. However, governance can also be a barrier as it could limit what users can do in the IoT, limiting innovation (Roman, et al., 2013).

Network

Network challenges in the IoT is another of the challenges that need to be addressed for its successful use (Roman, et al., 2013). The success of the IoT depends largely on the availability of a good network as it is an enabler (Lee & Lee, 2015). The vast availability of IoT can create...
traffic and bottlenecks in the network, therefore networks in the IoT remain a challenge (Sicari, et al., 2015). Network challenges expand to security challenges with sensor networks, mobile communication network, the Internet, and privacy challenges linking to network authentication, access control and data management (Zhao & Ge, 2013).

**Methodology**

The research took an interpretive view of the world using qualitative research methods in a subjective approach. Qualitative research methods seek to analyse qualitative data collected through qualitative research methods such as interviews (Bhattacherjee, 2012). The research used semi-structured interviews as the primary data collection method. The total number of interviews carried out was 12. The interviews were with Heads of Information Technology (IT) and C-Level IT Specialists in South African retail businesses, the average duration for an interview was 40 minutes. The research used a non-probability sampling method, using purposive sampling techniques to select individuals in large retail businesses in South Africa (Saunders, et al., 2009). Table 1 shows the profile of the respondents for this research. The data was collected in a cross-sectional period (Saunders, et al., 2009).

**Table 1: Profile of Respondents**

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Description of respondent</th>
<th>Interview Type</th>
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<tr>
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<td>Respondent_2</td>
<td>General Manager: IT</td>
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<tr>
<td>Respondent_3</td>
<td>IT Solutions Executive</td>
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<td>Respondent_4</td>
<td>Enterprise Architect Executive</td>
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<td>Respondent_5</td>
<td>Regional IT Executive</td>
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<td>Head of IT: Central Applications</td>
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<td>Respondent_7</td>
<td>IT Operations Analyst – Retail Systems</td>
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<td>Respondent_8</td>
<td>IS Executive: Head of Architecture and Innovation</td>
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<td>Respondent_9</td>
<td>Head of IT Infrastructure and Acquisition</td>
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<td>Chief Information Officer (CIO)</td>
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<tr>
<td>Respondent_12</td>
<td>Chief Information Officer (CIO)</td>
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**Technology Organisation Environment (TOE)**

The TOE Framework was used to guide this research. The TOE Framework assumes that there are 3 factors that influence users’ decisions to adopt or not to adopt a technology. These are Technological factors, Organisational factors and Environmental factors. Technological factors are all the technologies that are available to the business, including those that the business owns. Organisational factors are the characteristics that make up the business, this includes size, slack, communication process and formal and informal linking structures. The
Environmental factors refer to the environment of the business, its competitors, the market and dealings with the government (Gutierrez, et al., 2015). For the purposes of the research, the technology was considered to be the IoT, the Organisation was retail businesses and Environment was the South African environment.

Results

Following the literature review, the study explored the barriers that limit the uptake of the IoT in South African retail businesses. The results were analysed using thematic analysis, to get meaning from the themes identified in literature and uncover new themes. The analysis followed Braun and Clarke’s six steps for thematic analysis (Braun & Clarke, 2006). These were:

1. Familiarise yourself with the data or immerse in data
2. Coding data
3. Identify themes
4. Review themes
5. Define and name themes
6. Write up

The results are based on the main research questions used to collect data that emanated from the TOE framework.

- “What technological challenges will IoT pose in South African retail businesses?”
- “What organisational challenges will IoT pose in South African retail businesses?”
- “What challenges will the South African retail environment have when using IoT?”

Technological Challenges

The results revealed that technological challenges in the use of the IoT in South African retail businesses include the lack of infrastructure to support the technology and cost of the technology. The technological context in the TOE considers the technologies that the business owns and those that are available to them (Khosrow-Pour, 2013).

Technological challenges in South Africa included the lack of technological infrastructure. Respondents revealed that compared to the technological advances globally, South Africa is still lagging. The technologies that enable the IoT are not widely available in South Africa.

“The biggest problem with technology changes is infrastructure in SA and unfortunately SA is still a little bit behind and at the moment we are being supplied with infrastructure, but it’s a very very true struggle to try and get it for example” (Respondent_1).

Contributing to this is the network and energy problems in the country. Respondents revealed that South Africa has challenges with the bandwidth which contributes to limiting the uptake of the IoT as it is not strong enough to support the proliferation of the devices and things.

“Years down the road, I can’t certain now. First of all, we battle with bandwidth in relation to around SA and into Africa. So, you know when you get that right all of that technology will fall into place” (Respondent_5).

Cost of the IoT is one of the main challenges and barriers in the uptake of the IoT in South Africa. Due to the low availability of the enabling devices, the cost remains high. Retailers
revealed that cost is the main challenge and if the technology is not going to make them profit instantly they would rather invest in other technologies.

“The other thing we have a challenge with is that it costs a lot of money. So, our IT department is measure by your cost to sale so we look at how much money did we make by selling stuff and then how much money did IT cost us and we manage all the time to bring down the cost of IT relative to the sale as a percentage” (Respondent_6).

The results further revealed that standards in IoT is also a challenge in South Africa as globally. Retailers revealed that the challenge is having different vendors supply the IoT. The challenge in this is ensuring integration with the devices as they are diverse. Governance or standards is a challenge that users still need to overcome to fully reap the anytime, anyplace and with anything benefit. “In terms of the availability of technology and the availability of tags and those kinds of things our challenge in that space is around standards” (Respondent_8).

Organisational Challenges

Organisational challenges that were revealed in the results included change management for employees in South African retail businesses. Change management has been a challenge in technology adoption in businesses. Employees are often not generally open to change when it comes to technology adoption (Frey & Osborne, 2017). The results resonated the same findings. The results revealed that change management is a barrier that limits the uptake of the IoT. Retailers revealed that with the use of technologies like the IoT this will be a challenge as employees do not like change as they fear technology like the IoT might be a replacement of their jobs.

“The problem with staff is people do not like change and like I mentioned earlier realistically when IoT becomes a big play in organisation to improve and to grow people are going to feel redundant” (Respondent_1).

However, the respondents mentioned that even though this might be seen as a challenge this will not be the reality of the IoT in South African retail business. Retailers revealed that the IoT will not replace jobs, but rather will result in the reinvention of jobs in the retail space. This, however, has created another challenge in the retail environment in South Africa. The IoT will create a new demand for technologists that will be able to effectively interpret the data in the IoT and manage the devices. Retailers are concerned with the unavailability of such skills in South Africa as currently IT is a critical skill in South Africa and therefore a challenge in finding compete people in the retail space.

“It depends on many factors like education and their skills and also their perception of what you are introducing in the business, you have to deal with that and address it to a lot of aspects before you can introduce it to the business so for instance our cashiers we employ like matric’s most of the time and they actually easily learn how to operate the till, but if you introduce a technology like that they can operate it, but coming from a support person my thinking is if it breaks do we have enough people to support us because we have to make sure that business continues to run all the time, what are the backup systems that we have that can actually have if those systems are not running and making sure that the business the business continues to run, but in a small scale you can equip some people to learn and operate them, but on the other side of the coin you have to look at support” (Respondent_7).
Environmental Challenges

The environmental challenge in South African retail business comes from the perception of the customer towards the use of the IoT. Retailers revealed that the major challenge in the South African environment is that the people are not exposed to technology and it is a challenge to get the people to embrace the technology. People in South Africa tend to hold on to processes that they are familiar with rather than exploring new technologies. This is a challenge and a limitation in the uptake of the IoT in South Africa.

“To help to this new innovative thing here in SA market, for us the biggest challenge is to make people believe in new innovations into new technologies because many people here in the market are very consecutive people they used something 10 years ago, they will come use it again because it worked and IoT is new which probably no one saw and touched before” (Respondent_13).

Technology adoption remains a challenge. South Africa has early adopters of technology, but only a small percentage of the population is willing. A contributing factor in this is the cost of these devices and things and therefore, the average South African is not able to interact with the devices. For example, some IoT devices and things in the retail business might require the customer to have a smartphone to fully access its capabilities and the reality is in South Africa, the greater population, your average South African does not have this capability. This also limits what the retailer can provide in the space of the IoT.

“For example, smart fridge, there are a number of them available in SA but the number of people that have them is very small, so if you use. You would need to have those intelligent devices in the home talking to our e-commerce capabilities and automating those orders, we just don’t find that yet because South Africans are not that technologically advanced. There are a few people who can afford to do that. Unless you have enough customers to justify business case and enough business case and efficiencies, it does happen. IoT is expensive and partly why X is waiting, we rather wait until the cost of the technology comes down before going to invest in it” (Respondent_4).

Future Directions and Expectations

The IoT is not a priority investment in retail businesses. Retailers have looked at the business case on IoT, but have not rolled anything out. Other retailers are still waiting for the IoT to be successful in order to fully adopt the technology. However, retailers stated that overcoming the challenges and barriers will be the first step to fully adopting the IoT. “Years down the road, I can’t certain now. First of all, we battle with bandwidth in relation to around SA and into Africa. So, you know when you get that right all of that technology will fall into place” (Respondent_5). Retailers see the IoT as an enabler of efficiencies and opening up new markets. The IoT is set to change the South African retail environment, offering various opportunities for retailers.

Conclusion

The purpose of the paper was to explore the barriers and challenges that limit the uptake of the IoT in South African retail businesses. The research used an interpretive stance using interviews to collect data. The TOE Framework was used to study the barriers and challenges that limit the uptake of the IoT in South African retail businesses. The results revealed that technological challenges are, infrastructure; respondents mentioned that the bandwidth in
South Africa is the biggest challenge and a barrier in the uptake of the IoT in retail as the backbone of these devices depends on the bandwidth, cost of the IoT in South Africa as the enabling technologies are not widely available as well as the lack of standards that govern the IoT to ensure that they can be integrated. Organisational challenges was the issue of change management; retailers stated that the challenge is getting their employees to understand that the IoT like any technology, will not replace their jobs, but will be a reintervention of the existing and more than anything will create new job functions. This will be a pro for the retail businesses, but also a con as this creates a new demand for skills and at currently South Africa has a shortage of skilled IT people. Lastly, the average South Africa does not have the capabilities that will enable them to effectively interact with the technology resulting in a small number of South Africans engaging with the IoT technologies and this is an Environmental challenge to retailers as it limits the number of the IoT technologies they can integrate in their business structure for the customer.

Acknowledgements

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Change Readiness Model for Sustainable Software Engineering

Ravi Foogooa¹, Chandradeo Bokhoree² and Kaviraj Sharma Sukon¹
¹ Open University of Mauritius, Mauritius
² University of Technology, Mauritius, Mauritius
rfoogooa@umail.utm.ac.mu; cbokhoree@umail.utm.ac.mu; directorgeneral@open.ac.mu

Abstract
In spite of considerable research on sustainable development, the world is still a very unsustainable place. Some researchers from the ICT field have tried to understand the link between their field and sustainable development. Green ICT research, however, focuses on how to reduce the impact of ICT hardware on the environment by reducing electronic waste or improving the energy efficiency of ICT devices. Although this is laudable, it is not enough. Research in Green ICT maturity exemplifies this point – it shows the increasing emphasis on using ICT to improve the organisation’s impact on the environment rather than mere greening of ICT.

However, the role of software in Green ICT has opened up a whole new avenue of thinking. Software drives hardware and is thus crucial for the exploitation of any energy efficiency of hardware. Early software obsolescence is also a factor impacting premature renewal of equipment resulting in further electronic waste. Appropriate software can also help greening of an organisation.

Researchers have investigated the characteristics of Green software and tried to propose Green software engineering processes and techniques. However, these practices involve people and their attitudes and beliefs towards sustainable software engineering impact the adoption of these practices. There has not been enough research in these human aspects of software engineering.

Previous research on models of pro-environmental behaviour was reviewed for an in-depth analysis of factors affecting software engineer’s adoption of sustainable practices at their workplace. However, in light of actual low adoption in the local industry, it would be difficult to test such models. Thus, an attempt was made to assess the readiness of software engineers to embrace the change towards more sustainable practices in software engineering in their company. Understanding the change readiness of participants helps craft strategies for change which have more chances to succeed.

Building on previous research on change readiness, a new model to assess change readiness of software engineers is proposed in this research.

Keywords: Green ICT, sustainable software engineering, green software

Introduction
The world continues on its unsustainable journey, despite considerable efforts on the international front to make countries agree on concrete actions to curb the impact of man on the environment. An important development occurred in 2015 with the latest Sustainable
Development Goals, but the starting point is far from the desired goals (United Nations, 2016). In parallel, ICT researchers and practitioners have taken note that while the impact of ICT on the environment could be brought to 2% of global emissions by 2030, ICT itself could reduce global emissions by 20% by 2030 (Global e-Sustainability Initiative, 2015). Green ICT, which encompasses both greening of ICT and greening by ICT, is thus an active field of research. In this endeavour, the central role of software is important to note (Mahaux, Heymans and Saval, 2011). Fortunately, a new niche area within Green ICT has been created to investigate sustainable software engineering. Research in this field has yielded many interesting ideas and techniques by authors such as Taina (2011), Naumann et al. (2011), Penzenstadler et al. (2012), Kern et al. (2013). However, there is still room for more research on the role of software in Green ICT (Lago, 2015). The role of software engineers in the adoption of sustainable software practices is crucial and needs further research.

The failure to include human factors in many software development projects is one of the reasons for the dissatisfaction with the resulting information systems according to Avison et al. (1999). This point is emphasised as well by Pirzadeh (2010) who found in their systematic literature review that human factors in software engineering have not been given their due attention although the trend is now increasing (Amrit, Daneva and Damian, 2014). Human factors play an important role in the performance of software development projects, even more than tools and techniques as per Curtis, Krasner and Iscoe (1988). These authors believe that a layered behavioural model encompassing individual, team and project aspects should be used to understand their role on performance fully. Although these views point towards the need for empirical validation, it is equally important to include human factors right from the conceptual stage in software engineering. It might be therefore interesting to include theories modelling human behaviour in software engineering research, especially pro-environmental behaviour.

Sustainable behaviour is considered to be a set of actions to meet certain needs of people but at the same time respecting the socio-physical assets of the planet such that the needs of future generations are not compromised (Brundtland, 1987). In the same line, sustainable software engineering behaviour is the consideration of socio-physical assets during the practice of software engineering. In practice, research on pro-ecological behaviour focuses on the protection of the natural environment. However, it has also been found that people who are pro-ecological will also behave in an altruistic and equitable manner (Tapia-Fonllem et al., 2013). It is thus reasonable to consider studies focusing on pro-ecological behaviour.

There have been different approaches used to explain pro-environmental behaviour:

- **Rational perspective** – in this approach, people are perceived as directing their actions towards optimising their benefits through pro-environmental behaviour. This approach is in line with the theory of planned behaviour (Ajzen, 2014) which has extended the theory of reasoned behaviour (Fishbein and Ajzen, 1975) which is a general theory for understanding decision making by humans.

- **Emotional perspective** – in this approach, people are perceived as directing their actions towards the environment by their personal affects. Personal affects refer to the personal feelings people have towards something and the potential effects their actions could have concerning these. For example, some people, who like animals, might not want to use products which have been tested on animals. Another example would be people who
recycle waste because they care for the environment. However, personal affects might also make people indulge in counter-environment actions as well. For example, people who love powerful cars might use them despite their effect on the environment because of their appreciation of such cars. According to the Norm Activation Model (Schwartz, 1977), which has been used to explain pro-environmental behaviour, people’s behaviour will change when their personal norms are activated. The activation of norms apparently occurs when people are conscious of the consequences of their behaviour and when they admit responsibility for their behaviour and the consequences which follow. Under such conditions, people will feel guilt and will act in such a way as to reduce guilt.

However, changing behaviour is not easy. In fact, disregarding this aspect can cause up to 50% of companies to fail in their change efforts (Kotter, 1995). Thus, early work on change management highlighted the need to “unfreeze, change and refreeze” to ensure successful change initiatives (Lewin, 1947). Although this recommendation seems quite reasonable, Weiner finds that it lacks scientific grounding and that, unlike individual readiness, organisational readiness for change has not been researched enough (Weiner, 2009). Moreover, many publicly available instruments for measuring change readiness lack reliability or validity (Weiner, Amick and Lee, 2008).

Weiner (2009) posits that the effectiveness of a change initiative depends on the change-related effort which itself has a precursor condition in the form of organisational readiness. According to Weiner (2009), organisational readiness for change depends on change valence (i.e. how much the people value the change) and change efficacy (i.e. how far the people believe they can implement the change). However, he also points out that high organisational readiness for change does not necessarily result in successful change. It also depends on the change related effort - he points out that previous research has shown that members whose commitment on "want to" motives rather than "need to" or "ought to" exhibit more cooperative behaviour which results in more successful change implementation.

Another change readiness model is from Combe (2014a) who considers that the drivers of change readiness are:

- Cultural readiness - degree of alignment of organisation culture and the change to be brought about
- Commitment readiness - extent to which the organisation is determined at different levels to implement the change successfully
- Capacity readiness - the ability of the organisation to make use of processes, know-how, familiarity, skills to help in fruitfully implementing the change

Another important work in this area has been by Molla, Cooper and Pittayachawan (2009) who has developed a Green IT readiness (G-readiness) model. The authors considered readiness as the ability of an organisation to adopt environmental criteria to its IT technical infrastructure and human infrastructure and management across the IT lifecycle in the organisation. After an analysis of the literature, they proposed that Green IT Readiness has multiple dimensions, namely, attitude, policy, practice, technology and governance. Attitude is the opinion of the IT staff on climate change and environmental sustainability. Policy refers to the policy of the organisation to apply environmental criteria in its IT-related activities. Practice refers to the extent of application of the organisation's policies in the IT lifecycle. Technology refers to the technologies used to improve the environmental impact of the
organisation. Governance refers to the way decisions are made concerning Green IT initiatives.

The change readiness models in the literature suffer from a lack of empirical validation. Moreover, they are general change management models. Sustainable software engineering is specific enough to require a change readiness model of its own especially as no change readiness model specific to sustainable software engineering has been found in the literature.

**Methods**

The research questions driving this research were as follows:

1. What are the factors affecting adoption of pro-environmental behaviour by software engineers?
2. How can the readiness of software engineers to adopt sustainable practices be assessed?

The research approach used was to carry out a purposive literature review on the topic with a specific emphasis on different theoretical models of pro-environmental behaviour and change readiness models. The approach recommended by Glanz, Rimer and Vishwanath (2008) was adapted to select applicable theories for our use:

- The theory must meet the minimum requirements for research and practice, i.e. it should be useful for research as well as practice
- The theory must have been used in current research in pro-environmental behaviour
- Evidence for the theory predicting or supporting pro-environmental behaviour change

These were then used to discover the factors affecting pro-environmental behaviour. There are no studies on the sustainable behaviour of software engineers. However, there are studies on Green IT adoption which concern users, management or general IT practitioners. These were used to inform the development of the conceptual model for sustainable behaviour among software engineers.

However, apart from understanding what motivates a certain behaviour, it is also important to understand how to change behaviour. This requires an assessment of whether the individuals in the specific organisation are ready for the change. Thus, several change management models were also reviewed to contribute to this research.

These were then critically assessed, and a new model of sustainable change readiness developed purposively in a holistic manner.

**Results**

**Sustainable Software Engineering Readiness Model**

The proposed Sustainable Software Engineering Readiness Model (SSER model) is inspired from the works of Weiner (2009) but it incorporated many common constructs found from the other relevant research and which were adapted to sustainable software engineering.

Accordingly, the readiness of a software engineer towards sustainable behaviour depends on the following variables as shown in the diagram below:
The Sustainable Software Readiness of a software engineer depends on the change valence and change efficacy. Change valence represents the value which the change represents for the person. A person who highly values a certain change will be more ready to make the change. Change efficacy, which is based on the notion of perceived self-efficacy (Bandura, 1982), is the belief in one’s ability to effect a change in one’s behaviour. Indeed, it is believed that people will be ready to adopt a certain behaviour if they feel they can make the change towards a certain result.

1. **Change Valence**

Change valence is influenced by:

a. **Awareness**

If one is aware of the problems caused by unsustainable software and the opportunities of sustainable software engineering practices, one will be more apt to change one’s behaviour. This is similar to the behavioural beliefs parameter in the Theory of Planned Behaviour (Ajzen, 2014). The Norm Activation Model (Schwartz, 1977) also includes awareness of need and awareness of consequences as two important parameters.

b. **Responsibility**

One might be aware of the unsustainability of software engineering practices, but one might not feel responsible for the consequences. In such cases, one might not feel inclined to change behaviour. This point has been noted in the Norm Activation Model (Schwartz, 1977) as well as in the form of moral disengagement in the Social Cognitive Theory (Bandura, 1989).

2. **Change Efficacy**

According to Gist and Mitchell (1992), self-efficacy is itself influenced by task demands, resource availability and situational factors. These factors are described below.
a. Task Demands
When confronted with a proposed change, a person will first try to know the nature of the change. The more they know about the change, the greater the chance are that they will form a positive self-efficacy judgement. It is important that they have reliable and accurate information on the change required. An absence of information or inaccurate information on the change could generate a fear of the change itself (Bandura, 1983).

b. Resource Availability
Once a person knows what change is needed, there is a need to assess whether one has the resources at one’s disposal to effect the change. Resources range from skills, experience, know-how, time, finance which are necessary for the change. These are linked to but are distinct from the support provided by the organisation (discussed below). A positive answer to the resources question will help the person form a favourable opinion on change efficacy. This point has been mentioned as well by other researchers albeit in the form of capacity to effect the change (Combe, 2014b)

c. Situational Factors
The last factor affecting change self-efficacy is the question whether the person feels that in the current situation, given their knowledge about the change and the resources available, they will be able to implement the change successfully. Several researchers have made the point that self-efficacy is contextual. Situational factors are determined by the following:

1) Support
The resources put at the disposal of the software engineer at his or her workplace to bridge the resource gap to effect the change in behaviour will have an impact on his or her self-efficacy towards the change. This is in line with the research of Gist and Mitchell (1992) and is also referred to indirectly by Ajzen (2014).

2) Technology
The technology available to enable the change is also an important situational factor. The one who has the necessary technology at his or her disposal will be more inclined to form a positive opinion on self-efficacy for the change. This is similar to what has been done by Molla (2009) who also had a technology dimension in his model of Green IT Readiness. However, this factor is also dependent on latest technological developments in the field related to sustainable software processes and techniques of sustainable software design and implementation.

3) Culture
At the workplace, one is not alone but forms part of a collection of people. Many researchers have noted the influence of others on subjective norms (Ajzen, 2014) or on the phenomenon of learning by observing others (Bandura, 1989). Thus, in an environment where people are favourable to change towards sustainable software engineering, one might be more ready to change one’s habits. The collective influence of the other members of the organisation, the written and unwritten rules of the organisation, all of which are embodied in the organisation’s culture will also impact on the perception of the software engineer’s readiness to change. This is in line with the Social Cognitive Theory (Bandura, 1989) which states that the social and physical environment will influence personal norms resulting in a specific behaviour (Combe,
2014c) also mentions that change readiness is dependent on the culture of the organisation.

4) External factors
External factors can have an impact on the sustainable orientation of the organisation. Factors which are known to influence pro-environmental behaviour are either formal, such as local and international legislation, or informal, such as stakeholder pressure (Molla and Abareshi, 2011).

Conclusion
In this research, the need to investigate software engineering behaviour was emphasised, and theories related to pro-ecological behaviour were studied. Change management was also considered important to be included in this study. A specific SSER model for assessing change readiness of software engineers to move to more sustainable practices was then proposed.

This SSER model is useful for future research as it is well grounded theoretically and is specific to software engineering. No such model exists in the literature.

The limitations of the research are related to the fact that it is based only on the literature. There is limited work on the behaviour of software engineers, and the literature is mostly about consumers in the context of their pro-ecological behaviour or IT professionals in the context of Green ICT. Thus, it is important to validate the proposed model with practising software engineers. It will give an idea of their views and readiness to move to sustainable software engineering as well as of the factors which would facilitate this change. Consequently, one would be able to craft a proper strategy to make the change towards sustainable software engineering happen.

Further research could also be carried out by implementing the strategy and studying its success rate.

References


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Examining the Impact of Gamification on User Experience in Different Contexts

Natalie Thompson, Darelle van Greunen
Nelson Mandela University, South Africa
natalie.meiring@gmail.com; darelle.vanGreunen@mandela.ac.za

Abstract

Gamification is a term for using gaming elements in non-gaming environments, in order to improve user experience (UX) and user engagement (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011). Gamification is, however, not as simple as merely taking gaming elements and transforming one’s product into a game. Rather, the system is augmented with specific elements that have a foundation in gaming. While the term, “gamification”, is relatively new to the field of UX research, the underlying principles and elements of gamification have been at the core of UX since its inception. In the early 1980’s, Malone (1982), published the first heuristics for designing enjoyable interfaces. Malone explored the concepts of why computer games were captivating and how the notions of what made games captivating, could be used in non-game contexts. The concept of using gaming elements to enhance user engagement has been clearly evident in numerous daily activities for many years. For instance, airlines have made use of frequent flyer miles as rewards, while banks and retailers have made use of various points and rewards systems. Numerous studies have been conducted which show how using elements of fun along with gaming elements, in non-gaming contexts, have motivated and changed people’s behaviour. In order for gamification to be successful in engaging people, it cannot be haphazardly applied to any activity or application. Gamification needs to be individually tailored and each case must be seen as a unique one (Usabilla, 2014). Gamification has become a fast-emerging practice in the business world, with a growing number of organizations adopting gaming techniques and game-style rewards in order to increase customer engagement. Despite this growing trend and the potential role played by gamification, the marketing literature lacks studies that explain the use of gamification in different contexts, users' perceptions of gamification and its effects on their attitudes towards the product. This paper addresses this omission by investigating the user behavior and attitude combined with user experience in a gamification context. This paper presents the findings from a case study which examined the effects of gamification on users' intention to engage in the gamification process and their attitudes towards gamification. Using a mixed methods approach, the results indicate that the perceived ease of use was surprisingly found not to be significantly related to people's intention of engaging with the gamification process. In addition, the perceived social influence was found not to be related to people's intention of engagement but was related to their gamification adoption attitude.

Keywords: Gamification, online registration system, behaviour, badges, motivation

Introduction

There is a dearth of empirical evidence on the effectiveness of gamification within specific contexts. Hamari et al. (2014) refers to the context of gamification as the core service or
activity being gamified. To date, the most commonly studied context for empirical studies has been within the education or learning domains (Hamari, Koivisto, & Sarsa, 2014). This paper aims to address that gap by focusing on a different context, which is an online event registration system, a sub component of an event management system. An online event management system is a strategic tool used to automate the activities and processes of effectively managing an event. This study focused on whether the implementation of gamification could motivate and influence the user's behaviour within an online event registration system.

An event registration system is a platform whereby an event organizer can set up an event and specify the various pieces of information that are relevant to the event in question. This includes specifying the exact information that the event organizer would like to capture from the person registering for the event, i.e., the registrant. Once the event organizer has configured the event on the system, the event then becomes available for the registrants to use and thus register for a particular event. An online event registration system provides many benefits to the organization making use of the software, such as:

• Online payments
• A simplified registration process
• Participant data is gathered efficiently and effectively
• Integration with other beneficial software, such as social networking sites and email

The next section describes the gamification elements that were introduced to the event registration system.

Case study
The System

Gamification can be used to align the business goals to the user’s actions by channeling them through game dynamics. This is one of the core concepts of gamification, in that it can be used to influence a user’s behavior (Blohm & Leimeister, 2013). Gamification needs to be designed with the goal of the system at the center of the design process. The three main goals of the system for this research can be narrowed down to registering for an event, referring a friend and sharing event information on social media. The notion is that, the more an event is shared, the higher the likelihood of an increased number of people registering for an event. The events that are made available on this registration system are athletic in nature. These athletic events include a variety of events such as single discipline events through to triathlons. In order to encourage the behaviour of sharing and registering for these events, various gamification mechanics were implemented in the system. Gamification mechanics are rules and feedback loops intended to produce an enjoyable experience in a non-game context (Kumar & Herger, 2013).

The primary mechanics that were implemented into the system were points, achievements, avatars, and badges. Badges are the most commonly studied gamification mechanic (Hamari, Koivisto, & Sarsa, 2014). A badge is a distinctive icon that appears when a user has reached a set of defined requirements and can be a powerful motivator (Webach & Hunter, 2012).

The system was designed to take into account the actions that a user took, and depending on these actions, the user would earn points and essentially level up. Levelling up is a gaming
concept in which the players of a game, or in this case the users of the system, would experience progression. In addition to earning points for actions, these actions unlocked achievements, which in turn unlocked rewards in the form of avatars or badges. An example of this would be taking the action of registering for a race, which results in the user being rewarded with a badge. Registering, referring a friend and sharing were actions that were encouraged by way of earning achievements.

An additional gamification mechanic that was implemented into the system, was that of a player journey. A player journey in this instance was designed to show the user’s progress of registering for events of a similar type. For example, in the scenario of triathlons, the player journey progresses from an easy entry-level event to a very challenging event. By registering for each event in any given journey, the user would unlock a reward (badge/avatar). The journey is designed to highlight other events that the user might not be aware of, thus encouraging registration for events that the user might not have been informed about. The following section describes the case study and implementation of gamification within the system.

**Method**

According to Hamari (2015) and Hamari et al. (2014), a literature review indicates that many empirical gamification studies have had various forms of methodological limitations. These included, but are not limited to, smaller sample sizes, lack of control groups and studies which were conducted in makeshift services. This study had a large sample (n=8945), including a control group which in this case was the non-gamified users and was conducted on a live system.

The study was purposefully conducted as a field experiment, thus capturing data from a live system with real users, as opposed to a laboratory setting. The data was collected via means of questionnaires and content analysis, coupled with system usage analytics, to increase the robustness of the findings. A/B testing was used during the collection phase to split the users into two groups. This resulted in one group having a gamified version of the system, whilst the second group did not.

The analytics sample (n=8945) consisted of real users of the system and via A/B testing were divided into gamified (n=4470) and non-gamified (n=4475) users. Questionnaires were presented to both groups of users, however, they were optional. The users (n=1069) that opted to answer the questionnaire consisted of both the gamified (n=503) and non-gamified (n=566) users. The questionnaires included closed-ended questions, with the option to elaborate as to why they made that choice, as well as, multiple choice questions. The questionnaires for the two groups differed. Both groups received the same questions pertaining to their experience and intention to use the system, however the gamified users furthermore received questions that were relevant to the version of the system that they received i.e. questions relating to the gamified features. The following section describes the findings of the case study.
Findings

The questionnaire revealed that the users, both gamified and non-gamified, found the system easy to use and would intend on using the system again (see Figures 1 and 2).

This indicates that there was a solid foundation of a usable system upon which to build and implement gamification features for the purpose of this study. The main goals of the system were to encourage event registration, referring a friend and sharing event information. The following section discusses the sharing goal and the findings from the gamification implemented, in order to encourage this goal.

Goal 1 – Sharing

The act of sharing event information was encouraged by way of displaying a modal which allowed the user to share on social media. This appeared once the user had successfully registered for an event.
Within the questionnaire, the users were asked if they had shared any event information on social media. Both groups showed a less than 50% sharing rate (see Figure 3).

![Figure 5 Percentage of users that shared an event on social media](image1)

![Figure 4 Percentage of gamified users that felt motivated to share event information on social media in order to receive a badge/avatar](image2)

The questionnaire results indicate that gamification did not motivate them to share event information via social media as can be seen in Figure 4. The gamification elements that were created in order to motivate this behaviour, were badges and avatars. The user would earn these if they shared event information on social media.

The questionnaire tracked the intention to share and the system usage analytics tracked the actual actions. The data shows that the users were rarely clicking on the sharing modal within the system itself. When users were clicking on the sharing modal, being gamified or not had no impact on it.

The system usage analytics were measured by means of a conversion rate metric. The conversion rate is the metric by which the success or failure of a given goal in a system is measured. A session represents a user’s single interaction with a system over a period of time. The conversion rate of a goal (e.g. event registration) is calculated by dividing the number of goal completions by the number of sessions. In order to determine whether or not gamification had any impact on the desired goals of the system, the conversion rates for the specific goals must be ascertained.

As an example, in the case of the goal which tracked when the users were clicking on the social sharing dialogue, the conversion rate was 1% for gamified users, which effectively means that for every 100 times a gamified user interacted with the system, it resulted in a single user clicking on the sharing dialogue.

The conversion rate for user’s clicking on the sharing modal was 1.32% and 1.08% for gamified and non-gamified users respectively. This indicates that the users were not clicking on the sharing dialogue in the system and furthermore that there was no significant difference between gamified and non-gamified users. Thus, the gamification had little to no impact on influencing the users’ behaviour to share event information.
**Goal 2 – Refer a Friend**

The refer a friend modal was displayed once a user successfully registered for an event. Additionally, the user could start the ‘refer a friend’ process from the dashboard. The data revealed that gamification had little influence on motivating users to refer another user to register for an event, as can be seen in Figure 5.

![Figure 5 Percentage of users that referred a friend](image)

Even though nearly a third of the users from both the gamified and non-gamified samples referred a friend, the gamification elements had little influence on this behaviour, as can be seen in Figure 6.

![Figure 6 Percentage of gamified users that felt motivated refer a friend in order to earn a badge/avatar](image)

Based on the questionnaire, the users indicated that they did indeed refer friends, however, the system usage analytics data indicated that they did not do this via the system. The analytics data showed that 1.09% non-gamified and 1.04% of gamified users referred a friend. This could suggest that the users were sharing via other means besides using the system. The third goal of the system was to encourage users to register for events.

**Goal 3 – Event Registration**

The questionnaire data indicated that both groups were satisfied with the registration process (see Figure 7).
The gamified users would receive a badge/avatar if they registered for an event, however, as can be seen in Figure 8, the results indicated that gamified users were not motivated to earn badges/avatars. Thus, the gamification elements failed to motivate the gamified users to register. The conversion rate for user’s completing the registration process was 37% for non-gamified users and 34.97% for gamified users. As these percentages are relatively low, this data supports the questionnaire answers in that the gamified users were not motivated to register more often in order to earn badges/rewards.

**Badges**

Badges were a substantial gamification mechanic implemented in the gamified system. However, this study revealed that the gamified users were not interested in sharing their badges/achievements with friends (Figure 9). The content analysis of the qualitative answers from the questionnaire indicated that the gamified users were predominantly not interested in sharing their badges/achievements via social media. This was primarily due to the gamified users indicating that the registration for an event was a private matter, as well as not wanting to appear as boastful.
The gamified users displayed interest in earning rewards (see Figure 10) and furthermore indicated interest in a non-financial reward (see Figure 11). However, when the rewards were simply that of a badge/avatar there was little to no enthusiasm in earning such rewards (see Figures 4, 6 and 8). This could be due to the gamified users finding no value in it.

The following section discusses the results of the findings.

Results

It was hypothesized that the addition of gamification elements to the system would influence the user’s behavior and motivation to share and register for events. However, no significant difference was found between the gamified and non-gamified participants. Below are possible factors to consider that may have been influential in why the gamification had no impact in this system:

- Low interaction rate with the system. The user did not interact with the system often enough for them to be influenced by the gamification elements. There was an average of 0.67% registrations per unique user.
- Social media fatigue. Social media fatigue is defined as the decreased participation of a user on social media when the user becomes overwhelmed with too much information (Bright, Klesier, & Grau, 2015). The novelty of sharing on social media has possibly worn off.
- Cost. Many of the events that are available on the system to register for are costly and require a considerable amount of training to prepare for. It is unlikely that the reward of a simple badge is going to be motivation enough for a user to enter an event that they otherwise would not have.

Many well-known organizations have had unsuccessful attempts with gamification. For instance, Google implemented gamification by way of allowing its users to earn badges reading the news and sharing with others what kind of news they searched for (Robson,
This failed as the users did not want to share that information. There are various areas to research in order to identify why the gamification did not essentially work in this system and how it could be improved upon going forward.

Future work

This exploration into gamification revealed various avenues for possible future research. For example, research which would include an in-depth analysis of whether there is any correlation between users’ view about social media and gamification. This is due to the fact that there were many users that specified that they simply did not like sharing information on social media. Research into whether a generational aspect plays a role could be of assistance too. Future work could furthermore include a longitudinal study as opposed to this cross-sectional research, in order to get a more in-depth understanding of the cause and effect of why the gamification features had no impact in this study.

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Teaching and Learning 3.0: Are academics ready?

Suraj Juddoo¹, Bhavish Jugurnath²
¹Middlesex University, Mauritius
²University of Mauritius, Mauritius
s.juddoo@mdx.ac.mu; b.jugurnath@uom.ac.mu

Abstract

It is a fact that ICT is becoming more and more pervasive; the realm of education, and more particularly higher education, is not exempted from the influences and impact of ICT. There are ICT tools such as presentation software which have been part of the teaching world since some decades now. There are also new emerging technologies such as cloud computing which promise to disrupt the way HEIs operate according to current literature in the area, and therefore have a definite consequence upon the teaching pattern. However, research studies denote that faculty adoption of emerging technologies is very low for teaching purposes. The aim of this research is to explore what could be factors which encourage adoption of ICT/emerging technologies by faculty in Mauritius. Thus, a broad literature has been undertaken in order to discover current factors cited by other authors. Then, a series of hypotheses have been formulated based upon recent review of factors and data collection organised involving staff of representative public and private universities in Mauritius. The analysis of those data resulted into a new model, termed as ETAMU (Emerging Technologies Adoption Model for Universities) which focused upon two major factors, effort expectancy moderated by age and perceived novelty of emerging technologies. Two other factors were also uncovered by the data analysis, namely understanding of university policies and range of support provided for ICT use.

Keywords: technology, higher education, technology adoption, emerging technologies.

Introduction

The teaching and learning methods employed by Higher Education Institutions (HEI) around the world has been evolving over the years. Technology is being used to enhance and support teaching and learning; some examples are (1) use of presentation software to help interaction between teacher and learners (2) use of learning management systems (LMS) such as Moodle and (3) multimedia software for visual teaching. Given the fact that most undergraduate students are digital natives, the students are more prone to use and communicate more effectively with the use of Information and Communication Technologies (ICTs). However, contemporary studies tend to point that there is a gap between lecturers’ intent of use and adoption of ICTs compared to students’ expectations of ICT use for their learning process (Lewis et al, 2013). Understanding the factors leading to this potential lack of adoption and use of ICT by faculty members is crucial for HEIs given the more competitive nature of the global higher education industry. In Mauritius, there are few public HEI and several private ones. The adoption and use of ICT by faculty needs to be investigated to be able to take necessary measures to enable HEIs to use ICT in an optimizing way for teaching and learning.

Some organisations are already deploying emerging technologies tools but are not receiving the expected value from it. This can be attributed to factors such as loss of control over the
usage of these tools and gross misunderstandings of the real impact that emerging technologies can have on HEI (Raufu, M.O, et al., 2016). There is currently no reliable scientific study which has been undertaken upon this aspect of faculty adoption of ICT in Mauritius. Thus, the aim is to uncover the main factors which might encourage emerging ICT adoption amongst faculty in Mauritius based universities. This study contributes to the field of technology acceptance and emerging technologies research in HEIs.

Data collection was carried out across University of Mauritius, a state owned university, and Middlesex University Mauritius, a private university, on an initial basis. Factors which have been highlighted in comparable research carried out in other countries such as USA will be evaluated and hypothesis validated.

**Literature review**

**ICT use in HEIs**

In this digital age, the internet has radically changed the way that we communicate, and technologies like e-mail and Instant Messaging (IM) are now used to set benchmarks for efficiency and effectiveness. These technologies have become the fundamental means of communication for most emerging technologies platforms. Emerging technologies, therefore, has the potential to support Higher Education (HE) by facilitating communication among its stakeholders and by simplifying and expanding the ways that they can communicate, exchange knowledge, and interact with other communities.

The introduction of new technologies suggested opportunities for partnerships, collaborations and a redefinition of university services. Responsibilities for student selection, course content development, tutorial support and library services could be divided up between different for-profit and not-for profit organisations was a thinly veiled aspect of the virtual university ideal (Halabi et al., 2002). The central role allocated to technology in educational reforms brought with it the fear that this was ‘technology-led’ change and that educational motivations regarding new reforms were being sidelined. According to the rhetoric of both policy makers and commercial organisations involved in promoting on-line learning, higher education was being swept up in the same ‘inevitable tide’ of global IT-enabled change that had transformed industries and public sectors across the world (Marriott, 2004). Therefore, it is imperative to ensure that ICT technology does not overshadow educational principles in the future.

**Technology adoption models in HEIs**

Technology adoption has been a widely researched area since some years now. Different adoption models have been devised in different context of use, whether organisational or individual. Some of well-known examples of models are TAM, UTAUT and TOE.

Unified Theory of Acceptance and Use of Technology (UTAUT2) is one of the baseline model applied to understand what are the main conditions which encourage adoption of technology in HEI (Lewis et al., 2013). Their results point to performance expectancy, effort expectancy, social influence and habit with more complex effects when gender is added as an interaction
term as the main antecedents leading to proper adoption of ICT by faculty. Moderators which have been applied are age and gender, as suggested by broad Information Systems literature. Thus, male faculty will be more prone to adopt ICT if the latter is easy to use, effort free and performance enhancing. On the other hand, female faculty will adopt ICT more if they are subject to social influence by people they perceive to be important. The authors have experimented with both established technologies, such as Blackboard, and emerging social media technologies such as Facebook, Twitter and LinkedIn. Thus, this definition of emerging technologies by Lewis at al. would need to be updated to reflect new ICT tools such as the use of cloud computing, virtual/augmented reality and web 2.0 amongst others. Amongst the main findings, it is reported that 86% of faculty do not use Facebook, Twitter or LinkedIn for classroom purposes. Most university students nowadays are digital natives and are expected to be using ICT for communication and learning purposes. Therefore, it is of paramount importance that faculty members nowadays are able to use ICT to converse more effectively with their students.

ICT adoption in Nigeria is being acutely encouraged by the government through mechanisms such as Education Trust Fund, National Telecommunications Policy, National Information Technology Development Agency, Nigerian Satellite Systems Programme, and Science and Technology Policy (Eze et al., 2013). The authors adopted a qualitative approach to their research to understand the ICT adoption phenomena in a deeper sense compared to quantitative research. Tornatsky and Fleitcher's (1990) T.O.E model has been selected by the authors because (1) it consists of wider generic explanatory constructs, (2) it enjoys wide applicability in empirical studies.

Hence, Eze et al(2013) focus upon finding factors affecting ICT adoption by institutions – this represents a more wide ranging scope compared to this current research which focuses upon faculty adoption of ICT use only. However, the sample being used does include deans of faculties. The main factors having a greater influence for institutional ICT adoption in Nigeria are internet connectivity and accessibility, funding and technology support among 13 factors.

Another interesting comparable research has been carried out in 2008 on Mid-Southern public US universities. The authors have used a qualitative narrative process to collect data from 25 respondents who were all involved in technology adoption in their respective institutions (Keengwe, J. et al., 2008). Even if the authors have identified Rogers’ Diffusion of Innovation Theory of 2003 as the most appropriate model to uncover technology adoption, it is unclear if their work has actually adopted this model. However, their main findings concerning the main factors impacting adoption of technology is summarized below:

**Organisational support:** Culture of the university needs to be pre-assessed before implementation of technology as it highly influences adoption capability. Technology vision, policies and procedures need to be present to allow proper and effective technology use. Finally, communication and awareness has been found to be of key importance with their data analysis (Keengwe, J. et al., 2008).

**Leadership:** Strategies and practices need to be implemented to accompany the adoption process; an external neutral evaluation body is recommended to evaluate the implementation of technology and measure the adoption efficiency with respect to faculty training and
student learning (Keengwe, J. et al., 2008). Finally, the identification and appointment of technology leaders to ease awareness and hence adoption of technology is recommended.

**Training and Development:** Appropriate resources need to be devoted in terms of allowing appropriate training to users, especially for emerging technologies. Thus, the environment for training and use of new technologies should be conducive towards their adoption.

**Resources:** Funding is definitely crucial for proper technology deployment and therefore its adoption. Furthermore, specific resources leading towards technology use by faculty such as instructional design support needs to be catered for.

Prescott (2013) has conducted a doctoral study upon influential faculty in adoption and implementation of educational technology at the University of Liverpool. In her thesis, she came up with a new revised technology diffusion model compared to Rogers (Prescott, 2013). The interesting contribution by Prescott is that she used the adopter category model from Rogers in attempting to differentiate the fact that personal traits of faculty would be essential to determine their technology adoption capacity. Hence, some people could be categorised as innovators and therefore more prone to adopt new technology, whereas others could be categorised as late majority, and therefore take more time to adopt technology – only when the technology and its use is seen as mature. It should be noted that the late majority category represents 34% of people, according to Rogers Diffusion of Innovation model. Other factors leading towards adoption are institutional in terms of support and conditions. Thus, she agrees with other research work that strategies, policies and practices coming from the leadership of a University are important determinants for faculty technology adoption. Strong leadership and proper encouragement are also listed as very important institutional factors. The relatively large amount of available technologies could act as deterrent for faculty adoption, and this refusal of adoption will be enhanced if the perceived efficiency of the technology is low (Prescott, 2013). Novelty factor, financial support, perceived benefits from use of technology and student expectations also rank highly among the factors which the author identifies as very important for technology adoption. However, her main stance is that all those factors, when combined together, generate unique contexts of technology adoption. Thus, for Prescott, asserting that one factor would be a sine qua non condition for technology adoption is not plausible at University of Liverpool.

**Research design**

Even if most contemporary research apply different ICT adoption factors, there are some overlapping ideas. After literature analysis, the current research organise potential factors influencing ICT adoption under themes as below:

<table>
<thead>
<tr>
<th>Theme</th>
<th>Factors involved</th>
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<tbody>
<tr>
<td>Technology driven</td>
<td>Effort expectancy, technology support and performance benefits</td>
</tr>
<tr>
<td>Organisationaly related</td>
<td>Strategies and policies implemented, funding availability for ICT adoption, management support/leadership and student expectations</td>
</tr>
<tr>
<td>Society driven</td>
<td>Peer influence and novelty factor</td>
</tr>
</tbody>
</table>
The amount of work which faculty estimate to be inputted from ICT use is clearly one factor which might affect ICT adoption. Thus, our hypotheses are:

**H1: the less amount of work involved in using ICT positively influence adoption by faculty**

The range and amount of support to learn and implement ICT would normally be very important for faculty to change their current ways of working and adopt ICT. The second hypothesis is:

**H2: the more the amount and range of technology support, the greater ICT adoption amongst faculty**

It could be argued that academics would be more willing to readily accept using ICT if they perceive that they will benefit from it in their everyday activities, hence improving their productivity and performance. Our third hypothesis is:

**H3: understanding and perception of benefits from ICT use will positively influence ICT adoption amongst faculty**

When faculty understand clearly the importance of ICT use through strategies and policies which have been clearly communicated and explained to them, they are more likely to use ICT. The fourth hypothesis is:

**H4: clear policies related to ICT use positively influence ICT adoption**

Financial support or funding available to faculty will positively motivate faculty to use and experiment with ICT – knowing that they have the financial support to acquire the technology they seek or knowing that there is a financial reward for ICT use will encourage faculty to adopt ICT. Thus, the fifth hypothesis is:

**H5: clear financial support or availability of funding positively influence ICT adoption**

Encouragement and support from line management might act as incentives for ICT use by faculty. The sixth hypothesis is:

**H6: effective leadership positively influences ICT adoption**

The fact that faculty perceive that they are expected to use ICT by persons they judge important should normally encourage them to use them. The seventh hypothesis is:

**H7: Peer influence relative to ICT use positively influences ICT adoption**

Some faculty might be boosted to adopt some ICT if they perceive that the technology is a new one and is rarely used. The final hypothesis is:

**H8: faculty will be more likely to adopt novel ICT.**

**Research methodology**

This research adopts a quantitative paradigm with the application of a random sampling methodology. Questionnaires are used in order to collect large amount of data rapidly. The
population that is considered for this study is faculties from Middlesex University and the University of Mauritius working both full-time and part-time. A total of 130 faculties are included in the sample. Questionnaires are distributed to the faculties directly and a copy of the questionnaire is also made available in survey monkey online.

**Research Instrument**

Questionnaires were preferred as it is more convenient to collect large amounts of data from a large number of people in a short period and in a relatively cost effective way. However, the answer can be biased or returned unfilled due to lack of interest of some respondents.

Our questionnaire consisted of 2 parts:

I. Section A includes personal profile of the respondent with respect to socio-demographic information such as age, gender, marital Status and level of education.

II. Section B consists of questions aiming to test the 8 hypothesis of the current research.

**Ethical considerations**

All proper guidelines relative to ethical data collections and anonymity of participants were preserved.

**Analysis**

In this section, data analysis is performed by using Microsoft Excel and SPSS. In some cases, cross tabulations, Chi-Square test, K-S test Mann-Whitney test and Kruskal Wallis test have been used.

**Reliability and Validity**

It is highly recommended to analyse the reliability of the collected sample of data before proceeding to statistical analysis. The instrument is reliable if the scores made by the respondents remain roughly the unchanged in repeated measurement (i.e. it follows a normal distribution). In line with the above, Cronbach Alpha has been used to determine the reliability. Cronbach Alpha is an indication of consistency and by how much the items in a sample group are interrelated in order to measure the reliability of the data. For a result to be reliable, the alpha coefficient must be greater or equal to 0.7 ($\alpha \geq 0.7$).

**Demographic Analysis**

Among the 61 respondents who participated, 44.26% candidates were males while 55.74% represented the female group.

The majority of the respondents aged between 30-39 years old were noted with a frequency of 29 candidate and a percentage of 47.50%. Then it was followed by respondents aged above 40 years with a frequency and a percentage of 16 candidates and 26.30% respectively. Finally, the younger respondents aged 18-25 years and 26-29 years have the same frequency of 8 candidates and 13.10%.

Among all the respondents, 62.30% of the candidate with a frequency 38 respondents have already complete their postgraduate while 31.20% respondents have completed their Doctorate. The frequency for the respondents who were diploma holder was 3 with a
percentage of 4.90%. There were only one respondent from the undergraduate category representing 1.60% of the total respondent.

From the sample collected, 63.90% were from Accounting and Finance course with a count rate 39 students while those from science were 14.80% with population size of nine. Others which consist of law, management, economics and IT have a frequency of 13 with a percentage of 21.3%.

**Gender and ease of use of ICT tools for teaching**

From a cross tabulation performed, it can be deduced that overall there are around 64% respondents who find using ICT easy and the majority for both male and female is that they find it easy (around 44%). Those respondents argue that this ease of use of ICT tools encourage them to make use of those tools for their teaching. To test whether there is an association between gender and easiness of ICT use, a Chi-Square Test for Association is used. The significant value of the Fisher’s exact test is 0.755, which is greater than 0.05 and thus the null hypothesis is not rejected and it can be concluded that there is no association between gender and easiness of ICT use.

**Age and easy use of ICT tools for teaching**

It has been deduced that the respondents aged 18-25, 26-29 and 30-39 years find ICT relatively easy to use compared to the respondents aged above 40 years. In order to test if there is an association between age and easy use of ICT tools for teaching, Chi-Square Test for Association is used. From the test, the Fisher’s exact test’s significant value is 0.028, which is less than 0.05 and as a result, the null hypothesis is rejected and the conclusion is that there is an association between age and easy use of ICT tools for teaching with a low strength of association (Cramer’s V) of 0.317.

**Range and amount of support**

The range and amount of support to learn and implement ICT would normally be very important for faculty to change their current ways of working and adopt ICT. From the Chi-Square test performed, it can be noted that the P-value of Fisher’s Exact Test is 0.049, which is less than 0.05 and as a result, we reject H0 in favour of H1 and conclude that there is an association between the amount and range of technology support and ICT adoption by faculty. There is a positive correlation however it is a weak one according to Spearman correlation with coefficient of 0.29.

**Perception of benefits from use of ICT**

It could be argued that academics would be more willing to readily accept using ICT if they perceive that they will benefit from it in their everyday activities, hence improving their productivity and performance. It has been deduced from a Chi-Square test that the P-value of Fisher’s Exact test is 0.063 which is greater than 0.05 and thus H0 is not rejected. Consequently it can be concluded that there is no association or correlation (Spearman correlation sig value is 0.167, which is greater than 0.05) between the understanding and perception of benefits from ICT use and ICT adoption by faculty.
Clear policies of ICT use

When faculty understand clearly the importance of ICT use through strategies and policies which have been clearly communicated and explained to them, they are more likely to use ICT.

From the Chi-square test, it has been noted that the P-value of Fisher’s Exact Test is -0.017 which is less than 0.05 and thus H1 is accepted and we can conclude that there is a low association when a university clearly explains policies related to ICT and ICT adoption by faculty with value of Cramer’s V of 0.376.

Financial support

Financial support or funding available to faculty will positively motivate faculty to use and experiment with ICT – knowing that they have the financial support to acquire the technology they seek or knowing that there is a financial reward for ICT use will encourage faculty to adopt ICT.

Since the P-value of the Fisher’s Exact Test (0.610) is greater than 0.05, we can accept H0 and conclude that there is no association between clear financial support/availability of funding and ICT adoption by faculty. This can also be supported by the Spearman correlation with its significant value (0.999) greater than 0.05.

Line management support

Encouragement and support from line management might act as incentives for ICT use by faculty. It has been noted from the Chi-Square test that the P-value of Fisher’s Exact test is 0.183 which is greater than 0.05 and thus H0 is not rejected. As a result it can be concluded that there is no association or correlation (Spearman correlation sig value is 0.417, which is greater than 0.05) between support demonstrated by line management and adoption of ICT.

Peer influence

The fact that faculty perceive that they are expected to use ICT by persons they judge important should normally encourage them to use them. Since the P-value of the Fisher’s Exact Test (0.103) is greater than 0.05, we can accept H0 and conclude that is no association between peer influence relative to ICT and ICT adoption by faculty. Moreover the sig value of Cramer’s V is 0.122 which is greater than 0.05.

Novelty of ICT

Some faculty might be boosted to adopt some ICT if they perceive that the technology is a new one and is rarely used. From the Chi-square test, it can be deduced that the Fisher’s Exact Test p-value is 0.006 which is less than 0.05 and thus we reject H0 in favour of H1 and conclude that there is association between adopting novel ICT and ICT adoption by faculty. However, there is a very low correlation according to spearman correlation (0.154).
**Multiple Regression Analysis**

In view of getting a better understanding of the influence of the different factors on ICT adoption in universities, a multiple regression analysis was performed. The results are presented below.

### Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.699&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.489</td>
<td>.294</td>
<td>.84323</td>
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</tbody>
</table>

The results show that 48.9% of variance in ICT adoption is explained by the regression model. However, the adjusted R square value is 29.4%, a lower value mainly caused to the relatively small sample size. Still, it can be concluded that the antecedents of ICT adoption have a substantial influence on the level of ICT adoption in higher education. Moreover, the regression model is significantly better than the baseline model ($F = 2.508 (8, 21), p = 0.44 < 0.05$), at the 5% level of significance.

### ANOVA<sup>a</sup>

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<thead>
<tr>
<th>Model</th>
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<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>8</td>
<td>1.784</td>
<td>2.508</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>14.932</td>
<td>21</td>
<td>.711</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.200</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the coefficients table below, it can be observed that three ICT determinants were found to have a significant effect on the level of ICT adoption in higher education, namely, amount of work, perceived ease of use, and ICT policies, all having significance values lower than the 5% level. Moreover, amount of work involved in using ICT is the one having the greatest influence with a beta value of 0.739, followed by ICT policies and perceived ease of use.
### Discussion of Findings

The main findings of this research are:

1) The expected ease of use of ICT tools positively impacts upon level of adoption of ICT tools by faculty. However, the results show that gender is not a factor which discriminates upon level of ICT adoption by academics due to ease of use as an almost identical amount of males and females academics report for ease of use and adoption intention. On the other hand, age is clearly a discriminating factor towards effort expectancy as for most academics over 40 years, around 50%, report that they don’t find ICT tools easy to use and acts as a deterrent for adoption.

2) Range and amount of support for technology use has been shown to account for a marginal but positive importance in the adoption of ICT.

3) No association could be displayed between perceived benefits of ICT use and its positive influence upon adoption of ICT.

4) An association could be clearly denoted between clear understanding of their university policies towards ICT use and their adoption for classroom use by academics.

5) Surprisingly, no definite association can be made between adoption of ICT by academics and financial support/funding they might be given as incentives for ICT use.

6) Line management support is also not a clear determinant for ICT adoption by academics.

7) Peer influence also does not seem to influence propensity for adoption of ICT by academics.

8) The novelty of technology proves to be a positive factor for ICT adoption.

9) When looking at the simultaneous effect of the factors on ICT adoption, three factors were found to be significant, namely, amount of work involved, perceived ease of use
and having clear ICT policies. The most influential factor was the perceived amount of work involved in adopting ICT.

Bearing in mind the results of our data collection and analysis, we can hence create a new model for faculty adoption of emerging technologies in the context of HEIs in Mauritius. We would term this new model as “Enhanced Technology Adoption Model for Universities (ETAMU)”. ETAMU segregates between major and minor factors impacting upon faculty adoption of ICT in HEIs of Mauritius. The major factors would be (1) ease of use of ICT tools, depending upon age of faculty, where younger faculty are more prone to adopt ICT tools if they are easy to use and (2) novelty of ICT tools involved. On the other hand, the minor or less impactful factors for adoption are (1) the range of support given to the faculty for the use of ICT and (2) the understanding and existence of clear strategic policies concerning ICT use.

**Conclusion**

This research has drawn upon previous studies in the area of technology adoption to inspire a new model, which has been termed ETAMU. The Higher education sector in Mauritius is undergoing through lots of changes and challenges recently, and one of the main cause is the rapid and tremendous evolution of ICT. Thus, if faculty staff does not engage themselves with using emerging technologies in their teaching activities, that could have negative consequences both upon student satisfaction and competitiveness of their employing universities. Hence, this research wanted to explore what could encourage faculty of both private and public HEIs in Mauritius to adopt emerging technologies.

The research concludes with our new model, ETAMU, which reflects technology adoption realities in Mauritius for the HEI sector. It also opens the gates for other research to validate this model in different contexts. One of the forthcoming update of this research would be to extend it to all public and private HEI in Mauritius.

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The application of Cloud Computing in the Tanzania Education Sector: Case study of Ministry of Education, Science and Technology (MoEST)

Tumaini Kabudi
University of Dar-es-Salaam, Tanzania
tumicpj@gmail.com

Abstract

The purpose of the research was to examine the development, access and application of cloud computing in the day-to-day operations of the MoEST activities and the problems that affect the original application with a view to suggesting its effective use at MoEST. The main data collection procedures for this research study were observation and semi-structured interviews with the departmental heads at MoEST. Findings reveal that most staff in the MoEST’s ICT section are not familiar with cloud computing technology or even its types. However, they were open-minded to any suggestion on what best cloud model should be used. Therefore, the researcher proposed a cloud model that will overcome most of the challenges facing the provision of education in Tanzania.

Keywords: Cloud Computing, Education Sector, Higher Education Institution, Tanzania

Introduction

Cloud computing is a vital and popular technology that has rapidly improved and enhanced the application of IT in the education sector (Pocatilu, Alecu and Vetrici, 2010; 2011; Rao, Sasidhar and Kumar, 2012; Shakeabubakor and Sundararajan, 2015). However, this seems to be an emerging field in Tanzania that needs research to establish its application in the education sector (Mtebe, 2013). Various authors and researchers have defined the meaning of cloud computing (Hayes, 2008; Zhang, Cheng and Boutaba, 2010; Yu, Wang, Ren and Lou, 2010). For the purpose of this paper, cloud computing is defined as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction ” (Mell and Grance, 2011, p.3). The rising use of technology to improve teaching and learning is becoming vital to the growth of the education sector (Othman, Madani and Khan, 2014; Sultan, 2010; Mtebe, 2013). Most developed countries, universities and famous branded companies have applied cloud computing in the education sector (Pocatilu, Alecu and Vetrici, 2010; Rao, Sasidhar and Kumar, 2012). For instance, Google and IBM proclaimed a cloud computing university initiative in 2007. The initiative focused on improving the knowledge of computer science students in order to understand better the novel paradigm of massive distributed computing. Later on, in 2009 almost 5 million dollars were awarded by the National Science Foundation (NSF) to fourteen universities to enhance their participation in the initiative (Sultan and Sultan, 2009).

In some parts of Africa, cloud computing is emerging as a current technological paradigm that advances education in the continent (Sultan and Sultan, 2009; Roux and Evans, 2011). A good
example was the partnership between Ethiopia and Microsoft to roll out 250,000 laptops to school teachers that are running on the Microsoft Azure Cloud platform (Sultan and Sultan, 2009). This initiative aims to keep track of students’ records and secure their data within their education system. With the case of Tanzania, the Ministry of Education, Science and Technology (MoEST) in Tanzania invested in the development of cloud computing resources in the education sector a decade ago. The Ministry believed that cloud computing would enhance access, quality and relevance of education, while improving teaching and learning. MoEST had various projects dealing with developing cloud computing in education (Mtebe, 2013). For instance, in 2010, MoEST signed a collaboration agreement with International Business Machines Corporation (IBM). The main aim of the partnership was to support the adoption of information technologies in key sectors of Tanzania’s development such as education, research and development. IBM, as part of the agreement, was required to promote cooperation with US universities on research projects. The research projects were focused smarter cities, cloud computing and business analytics (Mtebe, 2013).

Despite all these efforts, the extent to which the potential of cloud computing resources are being exploited in day-to-day activities of MoEST is not clearly known to some stakeholders and the public. The main purpose of the research was to examine the development, access and application of cloud computing in the day-to-day operations of the MoEST. Specifically, the objectives were to:

- investigate the methods in which cloud computing was acquired;
- examine the ways in which cloud computing was being used;
- determine the factors that influenced its use at MoEST; and
- suggest a cloud computing model that is suitable in education sector;

Literature Review

Cloud computing technology has gained much traction recently (Pocatilu, Alecu and Vetrici, 2010; Hirsch and Ng, 2011; Othman, Madani and Khan, 2014). This is associated with the benefits including reducing capital cost for implementing hardware and software and providing flexibility in terms of resource provisioning (Fan, Cao and Mao, 2011; Mell and Grance, 2011), enabling data and services to be publicly accessible (Noor, Mustafa and Chowdhury, 2010; Ercan, 2010; Mtebe, 2013), assisting the rapid increase in mobile device usage, increased data reliability, organizing admissions and enrolment procedures (Rao, Sasidhar and Kumar, 2012). To date, Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are the main popular cloud services models. SaaS provides a user with IT or software applications as a service where the user can access the programs from any device. In regard to PaaS, users are provided with a computing platform and developmental platforms to help IT geeks to develop, test and deploy Web-based applications. With IaaS, users are offered hardware, storage services and computing power to host and manage their applications. Most of the services offered by IaaS are available on a pay-as-you-go manner (Sultan and Sultan, 2009; Fan, Cao and Mao, 2011; Mell and Grance, 2011; Lennon, 2012).

In terms of deployment, public, private, community and hybrid cloud models are deployed differently to address various needs (Sultan and Sultan, 2009; Fan, Cao and Mao, 2011; Mell and Grance, 2011; Lennon, 2012). Specifically, public cloud is a cloud deployment model where the computational resources and content are accessible to the general public over the
network. It is, however, not recommended for an institution with security concerns to utilize this kind of model (Sultan and Sultan, 2009). In a private cloud, computing resources and content are stored offsite or within the institution sites (Fan, Cao and Mao, 2011). It has to be noted that the community at large cannot access private cloud. Besides that, community cloud model is deployed differently, whereby cloud resources are shared by various organizations that have common interests such as security issues. With this model, the institutions that form the community cloud and public have access to the community cloud (Mell and Grance, 2011). Apart from that, the hybrid model coalesces private and public models, and is commonly deployed by institutions (Lennon, 2012).

As stated in the previous section, the application of cloud computing has turned now to the education sector (Rao, Sasidhar and Kumar, 2012; Roux and Evans, 2011). Most technologies that were previously expensive are now affordable or free to users who have access to the cloud. Most students are using various applications such as Google Apps, Wikis and blogs to assist them with learning. There are various initiatives taken by higher learning institution to embrace cloud computing services. For example, Maryland Institute College of Art, Boston College and New York University are pioneering academic organizations in using cloud-based applications (Jain and Pandey, 2013). These institutions have integrated Google Apps and FolderWave to admit students, as collaborative tools and system management. Moreover, various British higher education institutions, such as the University of Westminster, Leeds Metropolitan University, the University of Glamorgan, the University of Aberdeen and Royal College of Art have adopted cloud computing applications in their system (Sultan and Sultan, 2009). However, some studies showed that cloud computing has not been clearly applied and adopted in the education sector (O’Sullivan, Jääskeläinen and Lönnqvist, 2009). According to O’Sullivan, Jääskeläinen and Lönnqvist (2009), only four percent of the academic organizations are using cloud computing in education. The remaining 96% are related to industrial services thus cloud computing in education sector is still in its early stages.

The usage and adoption of cloud computing in African educational institutions is in its infant stage (Kshetri, 2010; Mtebe, 2013). Few educational institutions in Africa have applied and utilized cloud computing. For example, Google partnered with University of Pretoria, University of Ghana, University of Mauritius and University of Ibadan to use its cloud services (Sultan and Sultan, 2009). The partnership involved training, consultations and grants. In East

![Image: Deployment and service models of cloud computing](Source: Shakeabubakor (2015))
Africa, institutions such as Kigali Institute for Science and Technology, the Kenyan Methodist University, University of Nairobi, Makerere University Business School and National University of Rwanda improved access to various Google cloud applications e.g. Gmail, Google Docs and Google Calendar (Sultan and Sultan, 2009). This was largely to overcome challenges they faced such as the poor IT infrastructure and their inability to upgrade software and hardware occasionally. This clearly shows application of cloud computing enhances education in Africa. It has to be noted though that none of the mentioned universities come from Tanzania

For the past decade, there has been remarkable improvement of ICT and internet access in particular in Tanzania (Mtebe, 2013). These advancements have encouraged many Tanzanian educational institutions, especially universities, to evaluate and in some instances to exploit the potential in using ICT to improve access to quality education (Mtebe, 2013). A good example is University of Dar-es-Salaam (UDSM) that has established various learning centres that offer courses outside the campus including the Centre for Virtual Learning (CVL) (Nihuka, 2014). CVL is an Open Distance and E-learning (ODeL) Centre at the university that coordinates the delivery of E-learning academic programmes. Although the government of Tanzania has allocated various funds for the improvement of the education sector, there are challenges that affect this sector and thus still low literacy levels (Mtebe, 2013). These challenges include overcrowded classrooms, social and cultural practices, insufficient budgetary resources, lack of qualified lecturers, out-dated learning and teaching facilities, and inadequate number of textbooks (Lwoga, 2012; Mtebe, 2013). Moreover, the actual usage of cloud computing in Tanzania, that was to overcome the mentioned challenges, is not clearly known. Thus there is a need to understand the application of cloud computing in the education sector of Tanzania.

Methodology

The research was conducted using the interpretivist paradigm. The interpretivist paradigm was adopted for the study in order to investigate the development, access and extent of application of cloud computing in MoEST by observing, collecting information and make meaning of the information. A qualitative research design was employed in order to understand the phenomena and examine problems that affect the original application of cloud computing in the education sector.

The study was conducted at the Ministry of Education, Science and Technology as an in-depth single case study. This is due to the fact that it is the ministry that is in charge of the educational institutions in the country. Furthermore, MoEST sets the vision, mission and policy of education in Tanzania. It is also responsible for providing facilities that assist in acquiring education in Tanzania. The study employed the non-probability purposive sampling technique due to the nature of the research. This sample was drawn from employees at MoEST. The target population of the research was management, administration, technical staff and support staff at MoEST. Purposive sampling was utilized in order to get the right sample population that will provide the best information to answer the objectives of the study (Kumar, 2005). Data were collected using qualitative research methods. Primary data were collected by means of semi-structured interviews and observation. Semi-structured interviews were believed to help collect in-depth data from the target population; this enabled the researcher to obtain the perceptions and feelings from the sample population regarding cloud computing. Moreover, the researcher, through the observation method, spent time in the same setting as the target population she was observing. Qualitative data
collected were analysed using content analysis that served to identify the most vital themes of the perceptions of the MoEST employees.

Findings and Discussion

The researcher interviewed the heads of department at MoEST. The selected departments were Secondary Education, Higher Education, ICT Unit, and the Research. The choice was based on the fact that the departmental heads are the ones involved with most projects implemented in the education sector. In order for the researcher to get the right information on methods in which cloud computing amenities were acquired, it was important for the researcher to interview and observe the technical staff at the ICT Unit. The age of the departmental heads and technical staff were across the range of 26 to 60 years. Most of the heads had teaching experience, varying from 3 to 32 years while the technical staff had from one to ten years of technical experience.

On the aspect of cloud computing introduction, one of the departmental heads said “The idea of cloud computing to be applied in education sector started with the Tanzania beyond Tomorrow (TBT) Programme”. TBT is “an innovative eLearning initiative that was launched by The Tanzania Ministry of Education, in partnership with high technology companies (Accenture, Intel, Microsoft, Cisco) and NGOs (Net Hope, Plan International, AMREF and World Vision)” (Simba, 2012). The main goal of this project is to bring eLearning to 4000 secondary schools in Tanzania. The TBT Programme comprises numerous programs and technological infrastructure, including cloud computing. To emphasize, one of the head said, “Cloud computing is a technology seen to store, download and access educational courses online”.

In terms of implementation, another departmental head stated, “We had to implement ICT initiatives first before adopting cloud computing in schools”. Various ICT projects were developed based on enabling security, accessibility, connectivity and uploading of course content. One of the ICT initiatives that was implemented before adoption of cloud computing is the National ICT Broadband Backbone. The National ICT Broadband Backbone is run by the Tanzania Telecommunication Company Ltd (TTCL) through the Ministry of communication science and technology (Simba, 2012). To date, the government has built the National ICT Broadband Backbone that covers 7560km OFC Backbone at almost all regional headquarters in Tanzania (Simba, 2012). With regard to other ICT projects that were conducted, the researcher had to interview personnel at the ICT Unit of MoEST. It was learnt that education is divided in various categories. The educational categories include Teaching and Learning; Administration; and Monitoring and Evaluation. For the purpose of this research, ICT projects that are run in the Teaching and Learning were considered. Teaching and Learning is further divided into Primary, Secondary, Adult and Higher Education sub-levels of education. The projects include:

- **BRIDGE IT**: This project aimed to deliver course content in the form of educational video via mobile phones and TVs in classroom settings. Nokia, Pearson, Vodacom network and International Youth Foundation sponsored this project.
- **No-PC**: is a project that focused on implementing noPC technology i.e. using one PC that will act as a server to run multiple monitors in a classroom. For instance, in a class of 25 students, only 5 computers will be kept instead of 25 PCs.
• **Saris System at Open University**: Is a system that was implemented to help Open University (OUT) to administer Course registration, Student election, Student Enrolment, E-Learning, Tuition Fees and Examination Databank online.

• **Science Technology and Higher Education Program (STHEP) Project**: is a project that aimed to increase the quantity and quality of higher education graduates through an improved learning; with focus on science and technology. The major components of the STHEP project are National Research and Education Network (NREN), Education Management Information System (EMIS), E-Library and E-Learning.

From what has been explained above, it is clear that cloud computing has not yet been applied in the education sector. Application of cloud computing in education sector is still an idea. One departmental head said “Cloud computing is quite advanced. So its security challenges need to be addressed first”. The researcher inquired of each departmental head and technical staff whether they understood what cloud computing is. It was observed that there was only one departmental head who actually knew about cloud computing. This was so because he was involved in the strategising making in the Ministry. On this aspect, one of the technical staff said,

*We are not told about new IT projects till the managerial staff informs us. It is the departmental heads that are aware. They are involved with the strategic decision making of the ministry. The researcher had to explain to the rest of the staff what cloud computing was.*

Another surprising observation was that none of the target population knew about existing cloud models. The managerial staff simply knew cloud computing as a modern technology. They were open-minded for a recommended cloud model that can be applied in education sector. Thus, the researcher recommended a cloud model that will likely succeed in dealing with most of the challenges facing education sector in Tanzania.

**Proposed Cloud Computing Model in Education Sector**

The Hybrid model in terms of deployment and SaaS in terms of service model are the recommended models to be applied in the education sector in Tanzania. As explained/stated in the review of literature, the hybrid cloud is the blend of two or more cloud models coalesced to offer the advantages of the various deployment models (Fan, Cao and Mao, 2011; Lennon, 2012). The researcher recommends the hybrid model to be a combination of public and private clouds. A Private cloud can be created and utilized by a single institution such as a university or school. Advantages of an educational institution to have its own private cloud includes security, control of data location, provision of educational content resources and guarantee of remote access (Fan, Cao and Mao, 2011; Lennon, 2012). With regard to public cloud, it can be created and managed by the MoEST, academic institution(s), or combination. Benefits of applying public cloud in education sector include customized pricing, data sharing, available storage space and provision of free updated productivity tools (Sultan and Sultan, 2009; Mell and Grance, 2011). Hybrid cloud will be deployed in education sector at two levels. The first level will include the cloud model being managed by education-focused supplier that provides educational application to the group of academic institutions. The second level involves the fundamental infrastructure or applications being hosted offsite by a public cloud provider. It has to be noted though that more sensitive technical components and applications will be preserved in private cloud(s) by the academic institution(s). Furthermore, such a setup of a hybrid cloud can create security, cost and apps complexity...
challenges. It is quite important for the apps and other educational contents with strict security prerequisites (example databases, data-at-rest and/or other shared storage systems) to be kept in the private cloud foundation. The other components with high requisites for front-end tiers (web servers, web application and load balancers) can be placed in public cloud infrastructure.

The recommended cloud service model to be applied in the education sector is SaaS. In SaaS model environment, the Tanzanian educational institutions utilize applications and software provided through various users’ devices via thin client interfaces (e.g. web browser). By adopting SaaS model, Tanzanian educational institutions do not incur costs and challenges installing hardware and software (Aljawarneh, 2012). Moreover, another benefit is educational institutions do not need to do maintenance on computing applications. The applications provided are mostly on their latest version. Also, Tanzanian educational institutions can now better influence and control personnel expertise. This can be done by moving attention from software maintenance to strategic decision making (Aljawarneh, 2012; Mell and Grance, 2011). Examples of staff to employ are Business Analysts, Enterprise architects and project managers. It has to be noted that the user (e.g. student or lecturer) who wants to access educational applications available in the cloud should register and get credentials to log in. Thus after logging in successfully, the user can select what content in the form of readable documents, video tutorials or lectures podcasts) he or she needs.

**Simulation of the Model using CloudSim**

The researcher simulated the model based on services and deployment of cloud. For simulation, CloudSim was used as a framework for modelling and simulating cloud computing. For the GUI part, CloudReports application was used. CloudSim is a current generalized and expandable simulation framework that helps consistent modelling, simulation and experimentation of developing cloud computing infrastructures e.g. data centres, virtual machines (VMs), memory, storage and bandwidth (Calheiros, Ranjan and Beloglazov, 2011).

In the setting of CloudSim, a CloudSim component is illustrated as an entity. A CloudSim component can be a class (theoretical or absolute), or set of classes that depict one CloudSim model (data centre or host). The cloud (whether in form of deployment model or service model) generally comprises the following elements such as:

- **Data Centre(s):** A data centre is responsible to manage various host entities
- **Hosts:** A host in cloud computing is an element that depicts physical computing server in a cloud. A host is allocated with storage, memory and the policy that allocates processing cores to virtual machines.
- **Virtual Machines (VMs):** it is important to have a VM policy. The VM policy represents the operations control strategies linked to VM life cycle that comprises provisioning hosts to VMs, VM creation, VM destruction and VM migration.
CloudSim follows basic java code steps from configuration to simulation. These are:

i. Set numbers of users for the designed simulation

ii. Modify the simulation by instantiating the common variable such as current time, trace flag and number of users

iii. Generate Cloud Information Service (CIS) instance

iv. Develop Data centre instance and then index it with CIS

v. Create hosts with their features

vi. Develop data centre broker instance

vii. Construct VMs with their characteristics

viii. Submit the VMs to data centre broker

ix. Develop cloudlets and postulate their characteristics

x. Submit the formed cloudlets to the data centre broker

xi. Start the simulation once there is an event to be performed

xii. Display and print results of the simulation

The researcher decided to take the Higher education sector as a scenario to demonstrate how the cloud computing model can be used and the procedures involved in their utilization. The Higher Education scenario will elucidate universities and colleges with IT infrastructure that should meet the needs of management, lecturers, students, research staff and IT staff. The proposed cloud model will provide users with the needed software and hardware. Moreover, the proposed model is believed to provide researchers and postgraduate learners with the essential software and hardware to enable their research.

CloudReports is the graphic mechanism that illustrates the simulation of cloud computing environment, utilizing CloudSim as its simulation engine (Teixeira Sá, Calheiros and Gomes, 2014). It has a user friendly interface that has report generation attributes. The reports for each simulation are generated in the form of HTML that can be imported by third-party programs e.g. Ocatave and MATLAB. The researcher used CloudReports to illustrate SaaS provider with an unlimited number of datacentres. Using CloudReports, the researcher could easily set various hosts and configure their resources in terms of bandwidth, RAM, processing capacity and power consumption. The researcher could also easily simulate the various users...
and VMs in such recommended model. Thus once the researcher is done with the simulation, the detailed results will be displayed on the result simulation panel. The detailed results reports show general information on how long the simulation took. It also shows what each host and datacentre host. It also illustrates graphs on resource utilization, power consumption, costs, virtual machines and cloudlets on the selected datacentre. Moreover it illustrates the log reports that show the simulation from the beginning to the end. As a limiting factor, the researcher decided to simulate cloud model that will be applied in part of education sector i.e. High Education Sector. The researcher chose Ardhi University, IFM University, Mzumbe University, SUA University and University of Dar-es-Salaam. Each institution was allocated with a private cloud (i.e. its own datacentre). Moreover each institution will access public cloud. Other parameters are shown below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM Image Size</td>
<td>10000</td>
</tr>
<tr>
<td>VM Memory</td>
<td>1024 Mb</td>
</tr>
<tr>
<td>VM Bandwidth</td>
<td>1000</td>
</tr>
<tr>
<td>Data Center – Architecture</td>
<td>X86</td>
</tr>
<tr>
<td>Data Center – OS</td>
<td>Linux</td>
</tr>
<tr>
<td>Data Center – VMM</td>
<td>Xen</td>
</tr>
<tr>
<td>Data Center – Number of Machines</td>
<td>20</td>
</tr>
<tr>
<td>Data Center – Memory per Machine</td>
<td>2048 Mb</td>
</tr>
<tr>
<td>Data Center – Storage per Machine</td>
<td>100000 Mb</td>
</tr>
<tr>
<td>Data Center – Available BW per Machine</td>
<td>10000</td>
</tr>
<tr>
<td>Data Center – Processor speed</td>
<td>100 MIPS</td>
</tr>
<tr>
<td>Data Center – VM Policy</td>
<td>Time Shared</td>
</tr>
<tr>
<td>User Grouping Factor</td>
<td>1000</td>
</tr>
<tr>
<td>Request Grouping Factor</td>
<td>100</td>
</tr>
<tr>
<td>Executable Instruction Length</td>
<td>250</td>
</tr>
</tbody>
</table>

To start the experiment in CloudReports, the researcher configured data centres, host configurations, and then add user characteristics, as seen in Fig. 3.

The results obtained after simulating the proposed cloud model based on the parameters are seen below.
Figure 9: The total time for each cloudlet to successfully be executed on the data centre.

Figure 10: Total operational costs

Figure 11: Number of cloudlets which have been effectively executed on the data centre.
Thus, from the above generated graphs, it is clearly seen how cloud computing is quite beneficial in Tanzania education sector. It is possible for Tanzania educational institutions to store almost all types of sensitive data and educational content with huge terabytes in the cloud. Moreover, students and lecturers can easily access information stored in the cloud using any computational device such as smartphones. Tanzanian students together with their lecturers can work, edit and share educational documents at the same time. From the simulation, MoEST can tune up or down the costs of cloud computing based on the business needs of the education sector. By applying cloud computing in Tanzania education sector, users minimize using paper which can be quite costly. It has to be noted though that despite the above mentioned benefits, vulnerability to security breaches is still a huge challenge of applying cloud computing in education sector. The security risks that may occur are isolation failure, compliance risks, data integrity, intellectual property, insecure data selection, malicious insiders and management interface compromise.

Conclusion and Recommendations

Cloud computing has a vital role in changing and improving the education system in Tanzania. The prime purpose of the research was to examine the development, access and application of cloud computing in the day-to-day operations of the MoEST activities and the problems that affect the original application with a view to suggesting its effective use at MoEST. It was found that cloud computing has not yet been implemented in the education sector. Thus, in order to provide the possibility of building a practical cloud model, it was vital to simulate a cloud model. The findings obtained are significant in developing cloud computing applications that will assist in the provision of education in Tanzania. The researcher proposes to meet the need of defining or delimiting cloud computing terms in future. The researcher also recommends the government to recruit consultants and auditors to propose the best educational applications that can be kept in an efficient cloud. This should depend on needs and characteristics of the educational institutions. Moreover, it is recommended that the adopters of the cloud model should plan and ensure smooth uniform transition for these educational institutions. Also, data protection mechanisms, data location configuration of SaaS provide should be analysed in order to meet integrity, confidentiality, and availability needs. In addition to that, it is recommended to identify the specific educational contents that should be migrated in and out of clouds. Also, there should be a policy for the accessibility and
migrant of data found in the cloud. By applying this kind of model, it helps in the development and quality of the education sector in Tanzania.

References

Adoption challenges of online lecturer evaluations: A case of Chinhoyi University of Technology (CUT), Zimbabwe

Josaphat Manyeruke, Mirriam Jengeta, Maxwell Phiri
University Of Kwazulu-Natal, South Africa
josphatmanyeruke@gmail.com; mjengeta@gmail.com; phirim@ukzn.ac.za

Abstract

In an effort to improve service quality, Universities introduced a system where the students evaluate their lecturers’ teaching. Chinhoyi University of Technology (CUT) introduced a system of online lecturer evaluation in 2015 and has seen a decrease in such evaluations. The purpose of this study was mainly to find out why there is a decrease in online evaluations. The research population considered all fourth year students at CUT. These were chosen because they were all subjected to both manual (hard copy) and electronic evaluations during their stay at CUT as students. They were therefore able to make a comparison of the two instruments. The researchers used a sample of 94 students out of a target population of 700 forth year students university-wide which is more than 10% of the population as stipulated by Lucy (2006). The questionnaire used to collect data had both open and close ended questions and data collected was both quantitative and qualitative. The researchers used non-probability quota sampling method. Results show that the majority (92.6%) of the students understood the purpose of evaluating lecturers but however were hesitant to do so as the process was linked to their (student) E-Learning portals, and, therefore feared lack of anonymity. Some also felt that such evaluations would not change and or improve anything. Of major interest was the view that in developed countries students don’t see the need to evaluate their lecturers when they are satisfied (Ravelli 2000); in Zimbabwe however, students fear lecturer victimization since the lecturer is also an examiner; hence end up not evaluating lecturers even if they are not satisfied. Major recommendations given were that Management has to explain to students how the evaluation process works and how anonymity is preserved through online evaluation. There must be another way other than students entering their registration numbers when evaluating their lecturers online. Those students who saw the significance of evaluations also recommended the blocking of students from accessing any other information from the portal unless they go through the evaluations first.

Keywords: Online Evaluation, Anonymity, Student evaluations

Introduction

Worldwide, many operations are being automated to reduce human error, monotony and transaction processing time. According to Anderson et al (2005) the main reason for module evaluation is to improve teaching tenure, promotion, and merit considerations. This paper seeks to find out why some students do not evaluate lecturers using this easy and flexible system. In a bid to increase student participation and flexibility associated with automation; Chinhoyi University Of Technology (CUT) Quality Assurance Department introduced an online evaluation system where students would log on to their portal anytime anywhere to evaluate their lecturers. The introduction of online evaluation of lecturers was meant to increase the
efficiency of the analysis of evaluation system as the system could analyse automatically the results from student assessments. However student evaluations have actually decreased. This study seeks to find out the perceptions of students towards online evaluation of their module lecturers. The study sought to find out why some students do not evaluate their lecturer and also the benefits associated with online students’ evaluations relative to manual evaluations.

According to Wayne as cited by Anderson et al (2005) when students at South Eastern University were given an option to evaluate lecturers either online or traditionally, 47.8% of students evaluated online while 60.6% evaluated their lecturers using the traditional method. Wayne et al (2005) concluded from the survey they carried out, online evaluations seem to give more effective means of gathering objective feedback than traditional paper-based methods and students can complete the surveys in a more efficient manner. Watt et al. (2002) as cited by Nulty (2008) argued that the use of web-based evaluation questionnaires can circumvent many of the shortcomings in the evaluation system for example data entry and administration and move to a quicker method of evaluation. Nulty (2008) recommended ways of improving online evaluations which include the following: (a) sending emails to students who do not respond to online call for evaluations as a way of reminding them to evaluate lecturers online. (b) Sending emails to academics to remind them to encourage students to evaluate them. (3) Providing something like prizes as incentives to those who evaluate lecturers online. Kasier et al (2002) found out that web-based process produces quantitatively and qualitatively superior student comments, boosted student happiness, and extra efficient use of faculty and staff time.

Reisenwitz (2016) acknowledges that in deed that online evaluations of lecturers have their shortcomings including low response rate. His research evaluates an investigation on non-response bias in an online context. The research by Reisenwitz (2016) looked at the personalities and demographic characteristics of students who evaluate and thus differs from this research which explores the adoption challenges of online lecturer evaluations.

According to Anderson, Dochy and Janssens (2005), lecturer evaluations by students were first used primarily for “informational feedback for them to be more aware of student needs. However, in the 1960s as more universities began to use these instruments in their curricula, the purpose clearly changed to a decision-making tool regarding salary, promotion, and tenure. Eng, Ibrahim and Shamsuddin (2015) see student evaluations as a tool to improve the quality and operation of teaching and learning process. The purpose of student evaluation, they said, is to help in the modification and transformation of future lecturers’ delivery, materials used for delivery, classroom management, methods of assessment as well as other module requirements. Whist it is being done by students, on more informed people, these evaluations help improves the learning process as it digs deeper into individual learner’s learning experiences. Nuty, (2008) believed that Student ratings are a valid, reliable, and worthwhile means of evaluating teaching. Major advantage of student evaluation according to Anderson et al (2005) include that it provides rapid feedback; is less costly to conduct; needs a smaller amount class time; is less susceptible to professorial influence; allows students as much time as they wish to complete; and, permits scholars many chances to evaluate faculty members.

Student feedback is essential to improve lecturer performance though relying on it may not be optimal Kasiar, Schroeder and Holstad (2002). Gezgin (2011) quoted Felton, Mitchell and
Stinson (2004) as suggesting that student’s award higher rating to instructors who are more attractive to them than the elderly. Students also believe that their assessments were an effective means of voicing their opinions about instructors’ teaching hence the evaluation may be biased. Level of class being taught, students’ interest in the subject matter before enrolling in the class, size of the class, gender, grades, rigour of the course, instructor’s warmth-inducing behaviour, students’ characteristics, course difficulty can potentially affect an instructor’s evaluation by students (Martin 1998, Greenwald and Gilmore 1997, Marsh 1987). In an online assessment pilot study by Ravelli (2000) students expressed the belief that if they were content with their teacher’s performance, there was no reason to complete the survey (in any format). It was therefore interpreted that the lack of student involvement in the form of evaluations may be an signal that the lecturer was doing a blameless job and not the reverse. Anderson et al (2005) highlighted that student’s worry about restricted access to computers, trouble memorizing computer passwords, not sure whether lecturers actually saw at the assessments as well as significance of questions.

Some drawbacks associated with this mode as seen by Anderson (2005) consist of the fact that it requires a computer; is reflected less precise by faculties unacquainted with online means; and elicits lower student response rates. According to Kasiar et al (2002), relying on student evaluation may not be optimal as it takes time since there is need for processing. This make students marvel if their comments are ever read or utilized. In addition, it is also challenging for students to remember individual lecturers in a course as there were many lecturers who taught them during the semester. Evaluation may also create some dissatisfaction in students as they sacrifice their spare time to fill in the form. Evaluation system has also created enlarged job for administration staff since remarks delivered by students are separately typed and distributed to each individual lecturer.

Although it is ahead impetus, the use of online module evaluation systems in higher education is comparatively restricted. Anderson et al (2005). The system by-passes many bottlenecks such as administration of instruments in class, data entry and administration. It is a Just In Time (JIT) evaluation model, Nuty, (2008). This simplifies work and adds more value to productivity. Online student evaluations are also fast, less time consuming, facilitates instant results and cost effective since no stationery is used (Otani, JoonKim and Cho 2012). Anderson, Cain and Bird (2005) believe that online student evaluations are free from subjectivity since it is done independent of administrators. Griffin and Cook (2009) believed that data from online student evaluations can be more effectively and efficiently utilised to intensify the superiority of teaching when the institution identifies aspects on the overall teaching performance of instructors, publicize the results and a well-timed response (Eng et al 2015). Another major advantage of online student evaluations is that students will be able to complete the appraisals any time they wish without being influenced by the faculty (Anderson et al 2005). This is possible since students can log on to their portal anytime of the day wherever they are and complete the questionnaire. Online also facilitates privacy of the students, and, allows students to input more considerate remarks than the outdated paper evaluation method. Online evaluation was easy to use, anonymous, gives room to offer more thoughtful comments. Students also enjoyed commenting on a class while still doing the course, and they liked the idea that the lecturer wanted to improve module teaching, Anderson, et al (2005).
Online evaluation is believed to produce lower numerical results; regular negative remarks and lesser amount of return from students. Students have dissimilar purposes to express gratification or displeasure toward their tutors. Coverage bias owing to sampled students reluctant to use the internet can thus elicit lower student response rate. Students have to have access to computers and internet connectivity for online evaluation to take place. Possible approaches to encourage student participation in course evaluation include the use of small sample per module so that at the end of the day students would have evaluated just a few and not all the lecturers. Eng et al (2015) proposed the use of shorter instruments and a revisit of the methods of administering the instruments. Nuty, D.D. (2008) suggested that, to motivate students to participate in course evaluation, the system may be left open for evaluation for two weeks up-to semester end. Further suggestions by Nuty (ibid) include giving student receipts after completion of evaluation.

Methods

The research population considered all fourth year students at CUT. These were chosen because they were all subjected to both manual (hard copy) and electronic evaluations during their stay at CUT as students. They are therefore able to make a comparison of the two instruments. The researchers used a sample of 94 students out of a target population of 700 which is more than 10% of the population as stipulated by Lucy (2006). According to Lucy (2006), 10 % of the target population adequate sample for a population that is above 200 and 40 % of the population is adequate sample when the population is underneath 200. A questionnaire was used to collect data had both open and closed ended questions and data collected was both quantitative and qualitative. The researchers used non probability quota sampling method in which each school formed a stratum. From the strata, every 8th student was selected as a participant. The following schools were used:

Table 1: CUT schools where the study sample was derived from

<table>
<thead>
<tr>
<th>School</th>
<th>Number Of Students</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurship and business sciences</td>
<td>351</td>
<td>58</td>
</tr>
<tr>
<td>Wildlife, Ecology, and Conservation</td>
<td>66</td>
<td>7</td>
</tr>
<tr>
<td>Art and Design</td>
<td>78</td>
<td>8</td>
</tr>
<tr>
<td>Agricultural Sciences and technology</td>
<td>65</td>
<td>7</td>
</tr>
<tr>
<td>Tourism and Hospitality</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Sciences and Technology</td>
<td>90</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>700</strong></td>
<td><strong>94</strong></td>
</tr>
</tbody>
</table>

More participants were selected from the school of entrepreneurship and business management in order to safely generalize results since it is the largest school in the university. Authority was also sought and granted by Management to carry out the study.
Table 2: Response rate

<table>
<thead>
<tr>
<th>Questionnaires distributed</th>
<th>Questionnaires received back</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>94</td>
<td>94</td>
<td>100</td>
</tr>
</tbody>
</table>

There was hundred percent response rate from participants. All the 94 questionnaires that were distributed to students were returned. This can be attributed to the fact students being fourth year and having started doing their dissertations understood why it is important to respond to questionnaires. Of the five students who argued lecturer evaluations are not important, one of them argued that he does not understand the purpose of evaluating lecturers, two respondents mentioned that they are not useful as the lecturers do not improve basing on previous experience, while another one argued that the process is not taken seriously by students hence not important. On the same point, another student stated that, “I don’t think it is done effectively at CUT.” While another one argued that online evaluations are of no value. When students were asked which method they preferred, the traditional hard copy paper or online, 57 which is 60.63% showed favor towards online method while 35 which is 37.23% highlighted that they prefer traditional hard copy approach. 2 (2.13%) did not respond to the question. When respondents were asked about the anonymity of online evaluations 67% of the respondents argued that they are not anonymous, 25.53% believe it is anonymous, while 7.44% did not respond to the question.

Figure 1: Preferred frequency of evaluating students by students
94 fourth year students responded to the questionnaire. 52 of the students which is 55% indicated they wanted to evaluate their lecturers at the end of each semester, 38 which translates to 40.42% indicated they wanted to evaluate their lecturers when they feel like, while four people which is 4.25% did not respond to the question.

![Figure 2: Evaluation frequency](image)

From the results, it can be seen that a greater number of students last evaluated their lecturers 2 semesters ago when the method of evaluation was still traditional.

**Importance of evaluating lecturers**

87 (92.55%) of respondents are of the opinion that it is important to assess module lecturers while 5 (5.32%) were of the opinion that it is not necessary, while 2 (2.13%) did not respond to the question. The reasons why respondents thought it important to assess their module lecturers include the following: lecturer evaluations help to improve the lecturers where they were arguing that lecturers continuously improve lecturers if they take the comments of students seriously. One respondent argued lecturer evaluations help to give management information on how lecturers are performing. It also helps management to check if correct procedures are taken when conducting lectures. Another responded also argued that student evaluations help management to know whether lecturers are working ethically. To add on to that, another student argued that for management to have a starting point to assist lecturers they must know where they are lacking hence the importance of student evaluations. Online evaluations also help to evaluate the importance of the module to professional development of students. It also helps to appraise lecturers so that Management get to know how their lecturers are performing and lecturers also get to know how they are performing and can improve on their areas of weaknesses. Eleven students mentioned this as a reason for appraising lecturers. Other reasons that were cited by students differently include the following:

To see if lectures conducted are of benefit to the student, to assess whether lecturer is effective and fair, to give feedback to the University so that relevant changes can be made, so that relevant authorities are aware of what happens in lecture rooms, to improve quality of
education through continuous improvements, to help articulate our views as students, so that we know we are moving in the right direction, measures performance of the students indirectly, it supports effective communication hence improved results, for students to know and measure their efficiency, so that I know the strength and weaknesses of information, to appreciate the efforts of my lecturer, because lecturers are humans and prone to making mistakes, to regulate any deviations, necessary to assist poor performing lecturers.

**Anonymity of Online evaluations**

![Anonymity of Online evaluations](image)

63 of the 94 students who responded to the questionnaire believe that lecture evaluations are not anonymous. They pointed out several reasons why they believe they are not anonymous: The main reason was that students use their student numbers to access the evaluation form. 30 out of 94 respondents pointed to this fact. Another respondent also argued that severs can recognize student account by use of a simple java script. Someone also argued that,”with technology you always feel like there is a man behind the two way mirror watching everything. Another one also argued that the name of the name of the online user is usually not hidden while another one argued that there is always a trail if one uses the internet. On the same note, two respondents also argued online evaluation is not anonymous as it can always be traced when one wants to know who made the comment.”ICT personnel have access to all information on assessment form hence they can manipulate the forms and track student identity” said another respondent while another one also argued trading can be done via IP addresses and with the introduction of Ruckus system all data usage will be monitored.

Twenty-four (24) respondents indicated that they believe online evaluation of lecturers is anonymous as no names are provided and because they have more privacy as you evaluate lecturers at your own time privately. There is also no face to face interaction. 61 of the 94 respondents indicated they have no fears in evaluating their lecturers online while 33 indicated they have fears in online evaluations. The fears they have include being failed by lecturers, no privacy and therefore lecturers might know who gave them bad evaluations, It is not anonymous, True responses might not be given for fear that the lecturer concerned will
not be happy and possibly find out who gave them bad comments through registration numbers and this might result in student getting poor grades as the lecturer is also the examiner. Respondents also argued they fear intimidation and victimization. The other reason was that it might bring tension between the lecturer and student.

Reasons behind the decrease of student participation after the introduction of online evaluations.

CUT students highlighted internet connectivity as one of the hindrances online evaluations. These results are the same as those revealed by Anderson et al (2005) where computer access, trouble memorizing computer passwords, doubt about whether lecturers actually considered the assessments as well as significance of questions as some of the factors that deter student participation in lecturer evaluations. In an online assessment pilot study by Ravelli (2000) students voiced the belief that if they were satisfied with their teacher’s teaching, there was no motive to participate in the survey [in any format]. Thus, it was interpreted that the lack of student participation may be an indication that the teacher was doing a good job and not the reverse. Reisenwitz (2016)’s research findings indicates that students may evaluate their students occasionally for no other reason besides convenience. Interestingly, unlike the results above, where evaluation of lecturer is taken casually to sound alarm of a poor performing lecturer, the Zimbabwean students do not evaluate lecturers for fear of victimization by the lecturers involved since the lecture is also the examiner. At CUT, evaluations are frequently completed close to the end of the semester before publication of results hence fear of failure by students.

Benefits associated with online students evaluations relative to manual evaluations.

One of the students in this research argued that he does not understand the purpose of evaluating lecturers; two respondents mentioned that they are not useful as the lecturers do not improve basing on previous experience. Contrary to the findings, Eng, Ibrahim and Shamsuddin (2015) believed that student evaluations help in the modification and transformation of future lecturers’ delivery, materials used for delivery, classroom management, methods of assessment as well as other module requirements. Anderson, Dochy and Janssens (2005), further argued that student evaluations can be used as feedback used to have more knowledge of student needs.. Eng, Ibrahim and Shamsuddin (2015) believed that student evaluations are used as a tool to advance the excellence and operation of instruction and learning process. From the research, results show that they understand the purpose of evaluations though they are not too sure whether they will not be victimized as evidenced by their response on anonymity above.

CUT students also believed that the instrument was more of a fault finding tool for lecturers by management. This was very clear when they were asked about the importance of assessing their module lecturers and gave such responses as: helps to give management information on how lecturers are performing; it also helps management to check if correct procedures are taken when conducting lectures; helps management to know whether lecturers are working ethically; for management to have a starting point to assist lecturers they must know where they are lacking hence the importance of student evaluations. Major advantages of student evaluation according to Anderson et al (2005) include that it provides immediate feedback; is
less expensive to administer; requires less class time; is less vulnerable to professional influence; permits students as much time as they wish to complete; and, allows students multiple opportunities to evaluate faculty members. It also helps to appraise lecturers so that Management get to know how their lecturers are performing and lecturers also get to know how they are performing and can improve on their weak areas; appraise relevant authorities of what happens in lecture rooms; to monitor lecturers who might not come for lectures without valid reasons; to assess competency as well as establishing whether lecturers are doing their job or not. Anderson (2005) acknowledged that nowadays evaluations are being used as appraisals tools. Student evaluations on faculty members were first used primarily for "informational feedback for them to be more aware of student needs. However, in the 1960s as more universities began to use these instruments in their curricula, the purpose clearly changed to a decision-making tool regarding salary, promotion, and tenure.

Other reasons cited by CUT students differently include the following: To see if lectures conduct are of benefit to the student, to assess whether lecturer is effective and fair, measures performance of the students indirectly, for students to know and measure their lecturers’ efficiency.

Anonymity of Online evaluations

67% of the respondents argued that online evaluations were not anonymous. They cited such reasons as students use their registration numbers to access the evaluation form. They also believed that servers can recognize student account by use of a simple java script. Of interest was the argument that with technology you always feel like there is a man behind the two way mirror watching everything; and that there is always a trail if one uses the internet therefore can always be traced when one wants to know who made the comment. ICT personnel have access to all information on assessment form hence they can manipulate the forms and track student identity”. There is also a possibility of account hacking according to respondents. Contrary to the above however, a lesser percentage of 25.53% believed online evaluations were anonymous, since there was no face to face interaction between the student and the lecturers concerned. They further suggest that the approach permits students to contribute additional considerate comments than the paper evaluation technique. This is what Anderson et al (2005) called less vulnerable to professional influence. Anderson, Cain and Bird (2005) further supported the view by pointing out that online student evaluations are done independent of administrators. The above results suggest that CUT students view online evaluations differently from others since there seem to be no or limited literature pointing towards lack of anonymity of the online evaluations.

Conclusion

This paper looked at Online lecturer evaluations versus paper based traditional paper-based evaluations where the purpose was to unearth why lecturer evaluations by students decreased after the introduction of online evaluations. Questionnaires were distributed to fourth year students and results showed that students are afraid of evaluating their lecturers online as they fear there could be tracked by the concerned lecturer. The major recommendation from the research is that there is need for education so that students feel the questionnaires are anonymous.
To increase student participation in online evaluations, university management must always strive to have and or ensure 100% computer and internet access by students including effective support staff manning the university computer laboratories throughout the semester. Off campus, students must be encouraged to reside at university recommended accommodation with access to internet. To reduce fear of victimization by students, lecturers must access evaluations only after the publication of results. There is a need to educate students on the fact that whilst they use their registration numbers to gain access to the portal, lecturers will only have the ‘rights’ to view comments made by registered students in a given module with suppressed personal details.

The way to access the form must be well explained to students and must be very easy to access. There is also need to improve network so that anytime students want to evaluate lecturers online it is easy to do so. Students can also be blocked or denied access to other menu options of the website unless they evaluate their lecturers. This can be done towards the end of the semester so as to force students to first evaluate their lecturers before they can view their fees balance, access module notes, access course work marks, and many other options.

University staff responsible can also explain to the students the importance of lecturer evaluations and the anonymity of students as many students feared they could be tracked. Evaluation form should appear on cut website not portal as students have to use their registration numbers to access the portal and therefore might result fear of being victimized.

The way to access the form must be well explained to students and must be very easy to access. There is also need to improve network so that anytime students want to evaluate lecturers online it is easy to do so.

The university can make an anonymous student blog so that students can express freely their evaluations on lecturer performance or can alternatively make use of an online suggestion box.

References


Electronic Supply chain management systems diffusion to mitigate oscillator effect

Thokozani Patmond Mbhele
University of KwaZulu-Natal, South Africa
mbhelet@ukzn.ac.za

Abstract

The amplified demand order oscillation is difficult to extirpate within the underlying silo-oriented decision-making and the dearth of integrated electronically-enabled supply chain management (e-SCM) systems. This paper proffers to establish factors engendering the pernicious BWE in the supply chain of the fast moving consumer goods (FMCG) industry. The paper further attempts to establish discrete dimensional patterns of interrelationships among the oscillating effects of challenges and underlying sets of mitigation strategies. The study has used descriptive and multivariate analysis methods on 448 responses to interrogate the challenges of a bullwhip effect from the perspective of e-SCM systems on selected FMCG industry. It reports that the bullwhip effect (BWE) in the FMCG industry is mostly generated by lead times in supply chain order replenishment process. It also notes that the extent of e-SCM system use correlates with the degree of communication on future strategic needs between retailers and suppliers. Puzzlingly, e-SCM systems do not facilitate the accessibility to advance economic information with the virtue of legal constraints in-house IT systems and template-based information exchange. The results provide fascinating perspectives in managing and addressing the challenges of a bullwhip effect and further enhance the overall efficient frontiers of supply chain performance and supply chain visibility and connectivity through integrated electronic supply chain systems networks.

Keywords: Bullwhip effect, Information sharing, e-SCM systems, Inventory positioning, TOE Framework.

Introduction

This study observes the lapse in integrity and probity that normally spurs amplification of demand order rate exceeding the actual demand order rates. Under these circumstances, this study has considered e-SCM systems, information sharing and inventory positioning to leverage upstream and downstream relationships in creating fundamental supply chain performance outcomes. The buttress premise of technological-organizational-environmental (TOE) framework underpinned by fraternity of coalescing theories assisted this study to determine the role of electronically-enabled supply chain management (e-SCM) systems, information sharing and inventory positioning on the challenges of the bullwhip effect (BWE) and further established patterns of interrelationship among the dimensions in the FMCG industry.

Research Problem and Objectives

The pernicious oscillator of bullwhip effect ascribes to the dearth of a holistic view of the supply chain network as a cause for cascading demand order variability (DoV) upstream. The
supply chain partners normally experience the cascading order variability at each supply chain echelon stage, with the downstream site that exceeds the tentatively stable real demand rate, and higher oscillations from node-to-node roaming upstream the supply chain network. The paper aims firstly, to determine the extent of interrelated role of electronically-enabled supply chain management systems as consumer demand orders cascading upstream supply chain networks in the FMCG industry. Secondly, to establish discrete dimensional patterns of interrelationships among the oscillating effects of challenges and underlying sets of mitigation strategies.

**Phenomenon of Bullwhip effect and Supply Chain**

Supply chain operations resonate with market demand vacillations although the amplification of order variability along the supply chain reflects the overshoot of the order cycle and the shortage. According to Coyle, Langley Jr, Novack, and Gibson (2013:16) supply chain management is viewed as “a pipeline or conduit for the efficient and effective flow of products/materials, services, information and financials from the supplier’s suppliers through the various intermediate organisations out to the customer’s customers or the system of connected networks between original vendors and the ultimate final consumer”. The supply chain management focuses on ‘the flow of physical products from suppliers through manufacturing and distribution all the way to retail outlets and customers’ (Simchi-Levi, Kaminsky, and Simchi-Levi, 2008:1). The bullwhip effect as a supply chain phenomenon revealed by a distortion (variability amplification and /or rogue seasonality) of the demand signal as it is transmitted upstream from retailers to the source of production (suppliers) (Wu and Katok, 2006). Demand chain management (as conduit of pernicious oscillation and vacuous of demand amplification) focuses on “a set of practices aimed at managed and coordinating the whole demand chain, starting from the end customer and working backward to raw material supplier” (Selen and Soliman, 2002; Bowersox, Closs, Cooper and Bowersox, 2013). Arguably, demand management works collaboratively and interactively both across intra- and inter-organisational on extended supply chain enterprises. Enterprise chain ‘develops consistent integrated forecast from customer demand orders and marketing activities as well as sales history for more responsive marketplace changes’ (Bowersox, Closs, Cooper and Bowersox, 2013: 127). In the same argument, Christopher (2011:3) astutely elucidates on demand chain management as “the management of upstream and downstream relationships between suppliers and customers to deliver the best value to the customer at the least cost to the demand chain as a whole”. Tanweer, Li, Duan and Song (2014:289) observe BWE as ‘a continuous conundrum, addressing the shift of a seemingly steady inventory demand into vacillating demand fluctuation in upstream supply chain’. These definitions indicate value creating of systems and movement of orders linked to multiple nodes as the description of network chain structure and linkage.

**Enterprising Supply Chain Information Technology**

Kosanke, Vernadat and Zelm (1999: 87) scrutinize the information and material flow on the enterprise as a whole and coined the ‘enterprise engineering’ as “an enterprise life-cycle oriented discipline for the identification, design and implementation of enterprises and their continuous evolution”. If the enterprise is considered as an information and material processing system and a complex socio-technical-ecological system of systems, information
system is ‘a view of the enterprise that sees it as an information processing system that includes humans and various information processing and communication technologies’ (Bernus, et al, 2016:87-88). Enterprise integration intends to establish an information system, which ensures that information is available in the right place at the right time, in the right quality and quantity, for the right consumers, so that the enterprise as a system can perform its functions. Retail model require fulsome strategic investment in information technology and infrastructure in the developing economies. This paper interprets the chain network as a complex web of interconnected nodes (representing the entities or facilities such as suppliers, distributors, factories and warehouses), and links (representing the means by which the nodes are connected on supply chain mapping flows) within the premise of TOE framework. Seemingly, the integration of development chain, demand chain and supply chain through information sharing mechanisms and electronically-enabled supply chain management on multi-level echelons has the propensity within the framework of technology-organisation-environment (TOE) to enhance customer-centric business strategies and ameliorate the pernicious problem of a bullwhip effect.

**Theoretical Framework**

The technology-organization-environment (TOE) framework was developed by Tornatzky and Fleischer (1990). The framework depicts that e-SCM systems adoption within interrelated and complex network of enterprise architectural supply chain design is influenced by factors pertaining to technological, organizational and internal and external environmental context. Firstly, it describes the factors influencing technology adoption and propensity to predict likelihood of e-SCM system adoption, and secondly, describing the process by which a firm adopts and implements technological innovations is influenced by the technological, organizational and environmental contexts. According to Lin (2014:80) the TOE framework is appropriate as major determinant of the decision to adopt e-SCM as “enabled by the characteristics of IT innovation itself”, while the extent of e-SCM adoption is “driven by organisational readiness, and influenced by environmental factors”, especially the situation of suppliers, customers and competitors (Zhu, Dong, Xu and Kraemer, 2006:601). TOE framework does not reside under the auspices of being a theory, and Oliveira and Martins (2011:110) assert that “the framework should be treated as an ‘interactionism’ framework that ‘demonstrates how various theories can be applied systematically and complementarily to explain an adoption phenomenon”. This study employs multiple adoption theories within the TOE (Kurnia, Karnali and Rahim, 2015:522) to explain different contextual factors. The comprehensive and well-received theoretical lens of adoption theory, dynamic capability theory (DCT), institutional theory, and network theory are being utilized to synchronize a number of key theoretical elements with tripartite phases. It assumes that “technological context describes the dependence adoption on the pool of technologies intra-and inter-enterprise as well as relative network benefits and compatibility. As the organizational context captures the enterprise’s scope, culture and network architectural complexity, the environmental context relates to facilitating and inhibiting factors in areas of operations” (Angeles, 2014:97).
**Technological Phase: e-SCM Systems**

The technological phase, underpinned by the adoption theory, points out that many innovations do not achieve the expected results for failure to satisfy the requirements of potential adopters (Figueiredo, 2005). According to Rogers (2003), adoption refers “to the decision of any person or organisation to use an innovation while diffusion is the process in which an innovation is communicated over time through certain channels among members of a social system”. The adoption of e-SCM has significant effects on business process change, collaborative relationships among trading partners and even business transformation (Giminez and Lourenco, 2008; Wu and Chang, 2012). It is viewed as information technology (IT) adoption that refers to “the adoption of new methods, processes, or production systems while e-SCM utilises broad features such as information exchange capabilities, joint decision making support and business process integration, to conduct value chain activities” (Liu, Ke, We, Gu and Chen, 2010). The e-SCM systems diffusion reflects “a process from internal diffusion among functional units within an organisation to external diffusion across inter-organisational trading partners when e-SCM becomes an integral part of the value activities” (Lin and Huang, 2012:164). This paper believes that the rationale to invest in infrastructural information technology (IT) projects and remodel the electronic supply chain procedures epitomize an impetus on suppliers’ willingness to cooperate and collaboratively espouse e-SCM adoption. In a similar vein, Yeh (2005:327-335) performs the correlation of factors in an e-SCM relationship where “resource dependence, trust and relationship commitment are positively related to the continuity of the cooperative electronic supply chain relationship; and risk perception is negatively related to the continuity of the cooperative electronic relationship”. In achieving the integrated value chain activities, “e-SCM uses Internet and related technologies to perform integration activities across extended enterprises and throughout the supply chain networks” (Lin, 2014:82). In turn, to establish a relationship between e-SCM assimilation and its outcomes, ‘the adoption should be aligned with the strategic increased cost-benefits’ (Sodero, Ravinovich and Sinha, 2013:333).

**Organisational Phase: Information sharing and Collaboration**

Organizational phase, underpinned by the dynamic capability theory (DCT) that elaborates more on how organisations and supply chains can integrate, build or deploy and reconfigure their internal resources and external competencies in changing environment (Teece, Pisano and Shuen, 1997; Newbert, 2007). The dynamic capabilities are critical for performance in technology-based environments as they determine the clockspeed (Teece, 2007), and electronic supply chain integration requires to be ‘embedded in the strategies and goals of partnering organisations as supply chain networks’ (Rajaguru and Matanda, 2013:620). Organisational phase subscribes to information velocity in terms of describing how fast information flows from one process to another, and information volatility as the uncertainty associated with information content, format, or timing, must be handled to add value to the supply chain (Wisner and Stanley, 2008; Simchi-Levi et al., 2008). Supply chain visibility relates to “organizational phase for the ability of the focal company (the supply chain leader) to access and share information related to the supply chain strategy and the operations of supply chain partners” (Cardi, Moretto, Perego and Tumino, 2014:2). Although the supply chain members can manage their inventory on the basis of customers’ demands using information sharing (Cho and Lee, 2011), collaboration in divergent supply chain networks can reduce the
harmful conundrum of bullwhip effect (Dominguez, Cannella and Framinan, 2014:85). Ryu, Moon, Oh and Jung (2013:316-326) astutely point out that ‘supplier-managed-inventory (SMI) program offers a competitive advantage for retailers with respect to higher product availability through replenishment frequencies at reduced inventory level’ (Chen and Chang, 2010); and ‘provides the supplier with opportunities ‘to improve flexibility in production scheduling and marketing efficiency through improved customer service level’ (Kang and Kim, 2012).

Environmental Phase: Inventory positioning and lead time

Integrated business environmental phase, underpinned by the institutional theory, where external isomorphic pressures from competitors, trading partners, and customers likely induce forms to engage in electronic SCM practices (Sodero, Ravinovich and Sinha, 2013). Organisational isomorphism refers to “the assimilation of organisations that co-exist in similar environmental conditions of value adding network” (Dacin, 1997; Deephouse, 1996). The linkage of environmental business practice (EBP) and diffusion should enhance the understanding of the role of suppliers, customers, and other supply chain members in diffusing e-SCM practices (Tate, Ellram and Golgeci, 2013). Further underpinned by the network theory, “any system is viewed as a set of interrelated actors or nodes” (Tate et al., 2013:266) whereby ‘the supply chain partners can represent entities at various levels of collectivity, such as persons, firms, countries and other participants in the network’ (Borgatti and Li, 2009:2). Network theory focuses on “the relationships that an organisation has with other organizations and how these relationships influence the organization’s behavior and outcomes” (Thorelli, 1986). Notably, the better positioning of the supplier on the underlying architecture of the supply network provides ‘access to novel information and innovative ideas embedded in a network’ (Kim, 2014) while reciprocally enhancing the performance of a buying firm, often the retailer. In considering the distance between inventory hub and consumption cycle, Simchi-Levi et al., (2008) recognise that the variance of the orders from echelon-stage in the network is an increasing total lead time cycle between that stage and the retailer. That is, $L_i$ is the lead time between stage $i$ and stage $i+1$ (it means an order placed by facility $i$ at the end of period $t$ arrives at that facility at the beginning of period $t + L_i$) (Snyder and Shen, 2011). The inventory optimisation as the discipline of continuously managing inventory policies can optimise supply chain performance against business objectives, changing market conditions, risks, and supply chain constraints. Thus, ‘the ability to rapidly respond to unplanned demand or demand variability and supply changes can prove to have significantly reduced supply chain costs’ (Simchi-Levi et al., 2008) and ‘better supply chain responsiveness’ (Heizer and Render, 2014). It has become increasingly necessary to move the decoupling point (push-pull system) in the supply chain to minimise the dependence on forecasts from an anticipatory model and to maximise the reactionary or demand-driven supply chain elements for a responsive model (Bowersox, Closs, Cooper and Bowersox, 2013). This approach is related to build-to-order supply chain (BOSC) in terms of responsiveness to market changes.

Conjoint of TOE: Build-to-Order (BTO)

The build-to-order (BTO) concept as “a production strategy attempts to fulfill customer orders in short lead times through responsive manufacturing and information exchange” (Miemczyk, Howard and Graves, 2004). Chen, Lua, Yua, Tzeng and Changa, (2003:25-37) highlight that
“build-to-order production systems rely strongly on the information sharing for tight integration of the upstream supplier of parts, the midstream manufacturer and assembler of components, and the downstream distributor of finished goods in the supply chain”. In developing interfaces of active strategic communication between customers and suppliers along BOSC, eSCM systems become essential to BOSC in terms of: “1) the configuration of forms and organizational capabilities in the supply chain that creates the greatest degree of flexibility and responsiveness (Heizer and Render, 2014); 2) changing environmental market/customer requirements in a cost-effective manner while incorporating certain characteristics of agile enterprise based on a technological collaborative and responsive approach utilising shared consumer demand information systems” (Graham and Hardaker, 2000; Griffiths and Margetts, 2000; Gunasekaran and Ngai, 2005; Sheu, Yen and Chae, 2006). According to Yusuf, Musa, Dauda, El-Berishy, Kovvuri and Abubakar (2014:500) agile supply chain competitiveness depends on “the accelerated speed of responsiveness, degree of resilience, level of reliability and strength of relationships amongst supply chain (SC) partners to improve supply chain performance”. The suppression of oscillator effect under agile SC strategy requires flexible organisations, adaptable technology on dynamic customer needs and highly competitive environment through continuously accelerated clockspeed responsive approach. Supply chain flexibility as “the flexibility to meet particular customer needs in supply chain” (Yi, Ngai and Moon, 2011) requires “the ability of all supply chain members within the supply chain to adopt a chain perspective and change or react to environmental uncertainty and meet the increasing variety of customer expectations without excessive costs, time and organizational disruptions or performance losses” (Zhang, Vonderembse and Lim, 2002, Manders, Cansels and Ghijsen, 2016).

Research methodology

Research design

The research design framework constitutes the blueprint and research toolkit for the data sources, data collection, data sampling methods and measurement, and statistical analysis of data. This paper used cross-sectional exploratory quantitative approach to analyse data, and the self-administered questionnaire survey instrument was used for the data collection. An exploratory study gains insight into a phenomenon, discover new ideas and enhance knowledge of the phenomenon from quantitative paradigm (De Vos, Strydom, Fouche and Delport 2011:95). Neelankavil (2015:104) asserts that exploratory research is useful in understanding a subject thought processes and provides insight into attitudes and perceptions. Creswell (2014:3) cites Newman and Benz (1998) who suggest that qualitative and quantitative methodologies are not as discrete as they appears and “should not be viewed as rigid, distinct categories, polar opposites, or dichotomies, however represent different ends on a continuum”. Quantitative research is defined as a method for “testing object theories by examining the relationship among variables which can be measured on instruments, so numbered data can be analysed using statistical procedures”, and it uses instruments that are more rigid in style for eliciting and categorising responses to questions (Creswell, 2014:4). Quantitative research is research that explains phenomena according to numerical data, which are analysed by means of mathematically based methods (Yilmaz, 2013:312). Research paradigms include ontology, epistemology, axiology and doxology as there are guided by research philosophies, namely positivism, constructivist/interpretive, pragmatism,
subjectivism, and critical. Saunders, Lewis and Thornhill (2016:107) define research philosophy as “the development of knowledge and the nature of knowledge”. This study used reliable and valid tools to measure the reality of e-SCM systems adoption in the South African FMCG industry hence it followed epistemology paradigm (Saunders, Lewis and Thornhill, 2016). Thanh and Thanh (2015:24) declare that “positivism views the world as operating according to set quantifiable principles, surveys as well as statistical analysis” that can be studied empirically (Goduka, 2012). Positivism believes that reality is stable and can be observed and described from an objective viewpoint without interfering with the phenomena being studied (Densoombe, 2014:2). Positivism is an epistemological position which requires an observable social reality be worked on and is thus an objectivist ontology (Lewis, Saunders and Thornhill, 2009:599). The deductive research approach is a research approach that begins with a theory and sets out to test hypotheses based upon the use of a theoretical framework (Truxillo, Bauer and Erdogan, 2015:38). The organisations in retail sales, logistics, warehousing, marketing, manufacturing and information technology hubs were the units of analysis in this study, as such the managers (senior and functional levels) including supervisory level (nonmanagerial) are the subjects within the organisations.

Data Collection and Survey Instruments

A survey instrument has been constructed based on the literature reviewed to establish the content validity of the instrument. A self-developed survey instrument was designed based on the constructs of the conceptual framework using structured questionnaires to enhance research objectivities. While it could be argued that objective scales are more insightful, the study uses the subjective scales because of the multi-sectorial nature of the survey. The pre-formulated constructs-based instrument (bullwhip effect, information sharing and inventory positioning) was pre-tested using key industry practitioners and academics on discipline-based for suitability to enhance face and content validity. The survey questionnaire was structured into five sections including typical demographic and general information; dichotomous questions (Yes or No) on general perceptions; sections three and four the degree of agreement or disagreement (where 5 represented “strongly agree” and 1 represented “strongly disagree” and last section enlisted numerous for an extent recommended by the respondents. According to Anderson (2009: 312) “the clarity about research questions and types of data collected should allow the researcher to identify the most appropriate quantitative data analysis tools to use on the main underlying option for parametric and/or non-parametric data”. The anonymity and confidentiality of the respondents from an ethical point of view tend to yield confidence and create avidity around participation in a research study.

Data sampling methods and measurement

Nonprobability sampling has some compelling practical advantages to meet the sampling objectives of the study (Blumberg, Cooper and Schindler, 2008:235). This sampling occurs when a researcher selects sample members to conform to some criterion (Cooper and Schindler, 2008: 397), and purposive sampling was selected. The purposive sampling method is a thoughtful choice of a participant due to the qualities possessed, expert knowledge of the participants, and upon the individuals whom are most knowledgeable about the phenomenon underlying the study. Referral sampling proved to be the most efficient and effective approach
that eventually yielded the majority of the potential respondents on the sampling frame. Snowball sampling relies on approaching few individuals from the relevant population and these individuals then act as informants and identify other members from the same population for inclusion in the sample (Welman, Kruger and Mitchell, 2005:69). The retailers (downstream supply chain) and capacitated suppliers (mid and upstream supply chain) in the selected FMCG industry constituted the population of 800 proportionate representative within five major retail chain stores in eThekwini Metro, KwaZulu Natal, South Africa and approximately 300 selective suppliers for these retail groups in food (dairy, frozen, canned and general) and beverages (hot and cold), and personal health care category were considered for this empirical research study. The sample size of 456 (260 retailers and 196 suppliers) was considered where Sekaran (2003:295) alludes to the fact that sample sizes of larger than 30 and less than 500 are appropriate for most research on population-to-sample size table. According to Sekaran (2003:294) and Bartlett, Kotrlik and Higgins (2001:48) the representative population size of 800 (retailers) and 300 (suppliers) in determining minimum returned sample size is 260 and 196 sample size respectively with an alpha of 0.05 and a degree of accuracy of 0.05. The alpha value or level of significance (0.05) would become enshrined as the threshold value for declaring statistical significance in this study. This study has produced a sample size of 448 respondents with return rate of 98% [(448/456) 100]. According to Krejcie and Morgan (1970) researchers typically set a sample size level of about 500 to optimally estimate a single population parameter, in turn, this will construct a 95% confidence interval with a margin of error of about ± 4.4% for large populations. Regarding an inverse relationship between sample size and the margin of error, smaller sample sizes will yield larger margins of error. Larger sample size generally leads to increased precision when estimating unknown parameters (Cooper and Schindler, 2008; Babbie and Mouton, 2001; Krejcie and Morgan, 1970). The method of distributing the questionnaire was self-administered through scheduled delivery and collection of questionnaires within the agreed time intervals to enhance the return rate. The relevant letters (gatekeeper’s letter, ethical clearance certificate, and consent letter to ensure confidentiality and anonymity) were constantly depicted to the gatekeepers where the researcher was given a permission to enroach their domain.

**Statistical Analysis of Data**

The statistical analysis was aimed to examine the research objective for this study. The summarised univariate technique examined the distribution of cases on one variable at a time using frequency distribution, descriptive statistics (mean and standard deviation). The multivariate analysis as statistical technique was organised around a scheme on dependence (multiple regression) and interdependence (factor analysis) procedures for underlying objective to develop models and dimensions that best describe the population as a whole. The following figure indicates the three critical supply chain factors that tend to generate bullwhip effect in relation to various operational organisation perspectives. These pernicious factors explicitly impact upstream site on magnified consumer demand order variability and indirectly affect downstream site on coping with less reliable order replenishment from upstream stages in the supply chain.
The fundamental framework to analyse the challenges of bullwhip effect on selected FMCG industry is constructed around inventory positioning, information sharing and e-SCM systems. Figure 2 shows that 92% insuppressible majority of the respondents agrees that e-SCM systems mitigate consumer demand order variability in the supply chain network, and further enhance the optimal inventory positioning (64%), while achieving better coordination on information sharing (76%). These key constructs of this paper give considerable understanding on the role of electronically enabled-SCM system and possible mitigation mechanism for consumer demand order variability. The electronic linkage for supply-side and demand-side chain partners indicates a better information sharing communication on inventory positioning to achieve integrated supply chain management processes. The e-SCM systems have the ability to rapidly respond to demand variability and supply changes to reduce supply chain costs and opportunity cost of lost sales.

**Descriptive statistics**

Measures of dispersion and central tendency give a summary indication of the distribution of cases and an average value by describing single variable within the exploratory study.
This section of the study advocates that e-SCM systems \((M = 4.56)\) are the most significant systems to alleviate the DoV in the selected FMCG industry. These systems seem to create agility and high flexibility that rapidly respond to changing market requirements from diverse customers by quickly delivering the right products and services through effective integration. The respondents ranked the e-SCM system with a standard deviation of 0.850 as “a mechanism to integrate trading supply chain partners at technical, operational and business level with efficient real-time information sharing and active coordination” to mitigate bullwhip effect (Ke et al., 2009:839). Although the electronically-enabled supply chain management systems are preferably significant to improve flexibility, rendolent with future strategic communication \((M = 3.88)\) and informal and formal information sharing \((M = 3.92)\) improves supply chain visibility, flexibility and responsiveness in the dynamic market. These process improvements are associated with high order fulfillment rate and the shorter order cycle time to enhance supply chain performance targets in the FMCG industry. The semantic view of e-SCM systems provides flexibility to respond \((M = 3.61)\) to emergency demand order changes despite the frequent practice that the organisations constantly hold a large inventory to avert inventory stock outs. The respondents agree that electronically-enabled supply chain system has significant role (highly ranked \(M = 4.46\)) to improve willingness to share sensitive and confidential information \((M = 3.60)\) based on trust, to offer greater control and access to advanced economic information \((M = 3.66)\). Additionally, the system will enhance profitability level \((M = 3.70)\) and establish common goals and mutual dependency \((M = 3.63)\) between collaborating supply chain partners. These positive indications are expected to further optimise inventory positioning \((M = 3.65)\) with significant reduction in lead times \((M = 3.75)\). In the same statistical approach, the majority of the respondents agree that e-SCM system, updated demand forecast, information sharing, strategic communication, inventory positioning and flexible response are the most important variables to ameliorate bullwhip effect. The indication of individual cases can be further assessed to develop interdependence among the variables using factor analysis.
Factor Analysis

The purpose of factor analysis is to discover discrete dimensions in the pattern of relationships among the variables in the survey instrument. This paper provides three reduced number of different factors that are explaining the pattern of relationships among the variables. This statistical technique intends to identify a relatively small number of individual factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 2012; Helizer, Hollis, de Hernandez, Sanders, Roybal and van Deusen, 2010). Nevertheless, its major objective is to reduce a number of observed variables into small number of underlying grouped factors in order to enhance interpretability and detect hidden structures in the data (Treiblmaier and Filzmoser, 2010:198). This study uses exploratory factor analysis as an attempt to discover the nature of the constructs influencing a set of responses on the basis of a common factor model (De Coster, 1998; Costello and Osborne, 2005). This model proposes that each observed response is influenced partially by underlying common factors and partially by underlying unique factors.

Table 1: Factor analysis on KMO and Bartlett’s test, rotated components and Alpha

<table>
<thead>
<tr>
<th>KMO and Bartlett’s Test</th>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</th>
<th>Bartlett’s Test of Sphericity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approx. Chi-Square</td>
<td>Df</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3662.946</td>
</tr>
<tr>
<td></td>
<td></td>
<td>465</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor Loading</th>
<th>Eigenvalues</th>
<th>Communalities Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: Supply Chain Integration system</td>
<td>Economic Information.</td>
<td>.756</td>
</tr>
<tr>
<td>Flexible Response</td>
<td>.751</td>
<td>.668</td>
</tr>
<tr>
<td>Confidential Information</td>
<td>.665</td>
<td>.652</td>
</tr>
<tr>
<td>Profitability Level.</td>
<td>.631</td>
<td>.592</td>
</tr>
</tbody>
</table>

| Factor 2: Supply Chain Lead time cycle | Reduce Lead Times | .762 | 1.587 | .647 |
| Mutual dependency. | .724 | .656 |
| Inventory Positioning | .698 | .603 |

| Factor 3: Electronic SC communication system | Strategic Communication | .613 | 1.136 | .608 |
| e-SCM Systems. | .600* | .441 |
| Informal and Formal Sharing. | .600* | .524 |

(Overall Cronbach’s Alpha = 0.842) ** Rounded off to 0.600.
Source: Compiled by the researcher from the SPSS statistical results.

The tests of appropriateness of factor analysis for the factor extraction include the ‘Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett’s test of sphericity’ for the extraction factors (Paulraj and Chen, 2007). The KMO value of this study is 0.832, which indicates a meritorious degree of common variance above the normally acceptable threshold of 0.50 for a satisfactory factor analysis to persist with analysis. Kaiser (1970) further stresses that a cut-off value is 0.50 and a desirable value of 0.80 is meritorious in order to proceed with
a factor analysis (Hair, Anderson, Tatham and Black, 1998:99). The value of the test of statistic for Barlett’s sphericity is large (3662.946) and the associated significance level is small ($p$-value = 0.000), suggesting that the data matrix has sufficient correlation to factor analysis. This study concurs with the suggested general rule of thumb that at least 300 cases should be used for factor analysis (Tabachnick and Fidell, 2007:613), while Sapnas and Zeller (2002) and Zeller (2005) recommend 100 or even 50 cases under some circumstances. Normality assumption pertains to the significance testing of coefficients, and factor analysis is a correlation technique, seeking to cluster variables along dimensions (Garson, 2012:59). The construct validity was evaluated using Cronbach’s Alpha reliability test while the convergent validity of the instrument was assessed by examining the factor loadings. Cronbach’s Alpha values range of 0.842, which implies reasonable test of reliability of the scales and the high-level of consistency among the items/variables or constructs before factor analysis. This omnibus alpha value reflects good internal consistency reliability in terms of the correlations amongst the factors and the adopted measurement scales. The tests results (reliability, sampling adequacy and significance) confirm that factor analysis is suitable for this data as items/variables correlate in a way that item grouping can be generated to develop patterns of dimensions and to represent factors (Burns and Burns, 2009).

Exploratory factor analysis was applied to ensure the undimensionality of the scales. Both principal component analysis and varimax rotation in SPSS were chosen to identify the factors where the number of factors was not specified in advance. The varimax method was utilized for simplicity to encourage the detection of factors each of which is related to few variables while discouraging the detection of factors influencing all variables. The purpose is to seek the rotated loadings that maximise the variance of the squared loadings for each, with the goal of making some of these loadings as large as possible, and the rest as small as possible in absolute value (Garson, 2012; Costello and Osborne, 2005). Eigenvalues (characteristic roots) measure the amount of variation in the total sample accounted for by each factor. Kaiser rule (Kaiser, 1970) recommends a drop of all components with eigenvalues under 1.0. In the extraction sums of squared loadings in this study, all eigenvalues are greater than 1.0. The proposition of each variance that can be explained by the factors is noted as $h^2$, and Tabachnick and Fidell (2007:621) define communality ($h^2$) as “the sum of squared loadings (SSL) for a variable across factors”. In this study, variables with high values are well represented in the common factor space with higher loading on each factor between 0.6 and 0.7 while variables with low values (e-SCM and formal and informal information) are not well represented in the common factor space or not well explained by the factor model. In the real data, Costello and Osborne (2005:4) suggest that the more common magnitudes in the social sciences are low to moderate communalities of 0.40 to 0.70. The factor analytic procedure has the primary goal of minimising the complexity of the factors by making the factor loadings more clearly defined, understandable and interpretable. Hair et al., (1998) call loadings above 0.6 “high” and those below 0.4 “low”, although one rule of thumb for loadings suggests 0.7 or higher to confirm that independent variables identified a priori are represented by a particular factor (Garson, 2012). The factor interpretations and labels confine to the assumption of face valid imputation of factor label (face validity) that is rooted in theory. The factors were interpreted as dimensions of supply chain n strategies to suppress BWE and individually labeled as follows.
The first phase of Table 1 presents the following four factors:

**Factor 1: Supply chain integration system**: The first dimension describes the magnitude of greater control and access to advance economic information over demand orders in the supply chain network. In sharing quality advanced economic information, Zhao, Xie and Zhang (2002); Lee and Kim (1999) and Jarrell (1998) concur that information sharing leads to high levels of supply chain integration and performance with dependable delivery and better customer service associated with higher order fulfillment rate and shorter order cycle time. Although supply chain integrated network of reciprocal interdependence relationship can be developed to derive greater and mutual benefit (Choi, 2008; Chen and Paulraj, 2004; and Rinehart, Eckert, Handfield, Page, Jr. and Atkin, 2004), the shared information asymmetries across and rational self-optimisation and opportunistic behaviours of supply chain partners impede the information sharing (Cachon and Terwiesch, 2009; Feldmann and Miller, 2003). The disharmony of information exchange indicates the impact of bullwhip effect including the efficient production (production variability), exceeding suppliers (supply variability), unfavourable customer service (service variability), lead time variability and higher inventory costs.

**Factor 2: Supply chain lead time cycle**: The second dimension describes the better lead time pooling in supply chain that combines the lead times from multiple inventory locations to keep inventory in propinquity to the customers. Cai and Du (2009) and Cachon and Terwiesch (2009) underpin that “lead time pooling and location pooling approaches create the centralised inventory location, and decrease the uncertainty with respect to the total demand in the supply chain network”.

**Factor 3: Electronic supply chain communication system**: The third dimension focuses on how e-SCM capabilities facilitate the communication of future strategic requirements in supply chain to enhance demand order replenishment frequencies. Presumably, the electronic system can enhance trust-based coordination structure, better communicate demand order replenishment requirements for consistent product availability and accelerate physical product and information flow capacity. The e-SCM systems seem to facilitate magnitude of supply chain integration and the predictive statistical method should be performed to determine the relationship between e-SCM systems and other independent variables.
Source: Developed by the researcher from contextual, conceptual and reflective supply chain learning approach.

The perceived technological attributes, descriptive characteristics of the organisation (size, scope and structure) and the retail consumer landscape industry and its dealings with supply chain trading partners, competitors and market environment manifest critical challenge on the underlying technology-organisation-environment (TOE) framework. The framework presents:

**Organizational phase (One)** presents supply chain integration system describing the pedigree of greater control and limited/constrained accessibility to advance economic information over demand orders in the supply chain network. The intricacy resonates on how organizations and supply chains can integrate, build, reconfigure and synthesize their internal resources and external competencies in the dynamics of the changing environment. The guiding principle is willingness to share real-time information on future strategic initiatives with supply chain participants in order to collectively satisfy customer demands faster and more efficiently while reducing the risks relating to inventory positioning. Nevertheless, the system further improves willingness to share sensitive and confidential information based on trust among supply chain partners. The advanced economic information sharing induces a moderate effect on greater degree of flexibility and customer responsiveness for supply chain performance targets to entrench profitability level in the dynamic market. The challenge of supply chain network integration and flexibility is influenced by dynamism of environmental pressures.

**Environmental Phase (Two)** presents supply chain lead time cycle describing the better lead time pooling from multiple inventory locations to keep inventory position in close proximity to the valued customers. The challenges of scope, culture and complexity of architectural
network from organizational phase requires congruence on goals and mutual dependency between supply chain partners consolidates distribution that enhances better clustering of supply chain lead time cycle and the optimal inventory positioning. The intricacy resonates where external isomorphic pressures from competitors, trading partners and customers that co-exit, co-evolve and compete in similar dynamic environmental conditions of value adding network. The concept of lead time pooling seems to reduce the inventory while keeping it close to customers for better positioning. In clustering the lead times for multiple inventory locations, the consolidated distribution strategy attempts to keep inventory close to customers while hedging against the second form of uncertainty. The other challenge of better lead time pooling is influenced by a certain level of information flow capacity to determine the magnitude of coefficient.

**Technological Phase (Three)** presents electronic supply chain communication system describing the supply chain electronically-enabled systems that enhance trust-based coordination structure, better communication of demand order replenishment requirements for consistent product availability and accelerates physical product and information flow capacity. The e-SCM systems adoption depicts the organisations efficiently and timely communicating the future strategic needs and demand order replenishments throughout the entire supply chain network. The intricacy resonates with technological innovations on how to achieve the expected results to satisfy the requirements of potential e-SCM systems adopters – on new technological methods, processes or production systems to entrench information exchange capabilities, joint decision making support and business process integration. The challenge relates on how e-SCM capabilities facilitate information sharing to communicate future strategic requirements in supply chain to enhance demand order replenishment frequencies on the oscillator effect.

**Multiple regression analysis on electronic supply chain management systems**

This study attempts to establish the correlation between variables that characterise the determinants of e-SCM systems in order to demonstrate how strong the relationship between variable is. The notations for the determinants of e-SCM systems were subjected to five-point Likert-type scales. The operational performance targets and outcomes after implementing e-SCM systems might be dependent on the enhancement of informal and formal information shared, strength to communicate strategies, willingness to share confidential and sensitive information, accessibility to advance economic information, improved flexible response, increased profitability level, mutual dependency and reduced lead times. The stepwise procedure produced two predictor variables (strategic communication and economic information) on model 2 and economic information is negatively correlated to e-SCM systems. The notation is that the greater control and accessibility to advanced economic information over demand has negative relation with the implementation of e-SCM systems. The correlation matrix presented all possible predictor variables and the dependent measure, the e-SCM system. The nine interval level variables indicate the relationship between all possible pairs of variables using significance level of alpha = 0.05. The criterion variable is negatively correlated to advanced economic information, flexible response and profitability level with a significance level greater than 0.05, while all possible predictor variables are positively correlated with \( p < 0.05 \) except sensitive and confidential information and lead times. Only two predictor variables were entered into the prediction model 2 after stepwise procedure.
with a multiple R of 0.279 and both future strategic communication and advanced economic information are significantly entered in the regression equation.

Table 2: Multiple regression analysis with E-SCM Systems (Dependent Variable)

<table>
<thead>
<tr>
<th>Regression results</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable – E-SCM Systems</td>
<td>Constant</td>
<td>Strategic Communication</td>
</tr>
<tr>
<td></td>
<td>3.659 (0.000)</td>
<td>.205 (0.000)**</td>
</tr>
<tr>
<td>R²</td>
<td>.069</td>
<td>.205 (0.000)**</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.067</td>
<td>32.877 (0.000)</td>
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<tr>
<td>F</td>
<td>32.877 (0.000)</td>
<td>18.718 (0.000)</td>
</tr>
<tr>
<td>Collinearity Statistics: Model 1</td>
<td>T=1.000</td>
<td>VIF=1.000</td>
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<tr>
<td>Durbin-Watson</td>
<td>1.800</td>
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<tr>
<td>Residuals Statistics</td>
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<tr>
<td>Mahal. Distance</td>
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<td>Cook's Distance</td>
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<td>.076</td>
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<tr>
<td>Centered Leverage Value</td>
<td>.000</td>
<td>.024</td>
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a. Dependent Variable: Electronic Supply Chain Management Systems, ** p<0.05

The multiple regression technique was chosen to hypothetically determine the relationship between the dependent variable (e-SCM systems) and predictor variables. Table 2 indicates that the coefficient of multiple determination is 0.078, with about 7.8% of the variation in the e-SCM system being explained by future strategic communication and advanced economic information. The regression equation appears to be moderate for making predictions since the value R² is not close to 1. The F ratio is 18.718 and significant at p = 0.000. This provides evidence of the existence of a linear relationship between the response and the two explanatory variables (strategic communication and advanced economic information). Among all eight dimensions, future strategic communication (β = 0.288, p < 0.05) and advanced economic information (β = -0.098, p = 0.05) were found to be considerably related to the e-SCM system. In the t-values, these values show the importance of a variable in model 2, and the percentages are greater than 1.96 at a significance of p < 0.05. Apart from that, since the tolerance value was more than 0.10 and the VIF was below 10, there was no multicollinearity problem between items in the independence variables. The maximum value of Cook’s distance is 0.076 under residuals, suggesting no major problem D < 1. Two models were produced by regression analysis without concern for the multicollinearity problem with both variance inflation factor (VIP) below 10 and tolerance more than 0.10 level, reflecting acceptable positions. In the case of normality, the scatter plot maintains points between the ranges of -3.3 and +3.3 without any outliers. The output stated the measure (min = 0.000 and
max = 0.024) of leverage on how much an observation influences the regression coefficient and this study reveals acceptable hat element within the rule of thumb (leverage goes from 0 to 1). In examining the degree of autocorrelation, model 2 indicates the value (1.800) of Durbin-Watson statistic consistent with the ideal range values (between 1.5 and 2.5) with no problems related to multicollinearity.

**Discussion of Research Objectives**

The antecedents of e-SCM adoption intention based on TOE framework incorporate perceived benefits, perceived costs, top management support, information sharing culture and business partner influence on inventory positioning (Teo, Lin and Lai, 2009:972). This paper proffers to establish factors engendering the pernicious BWE in the supply chain of the fast moving consumer goods (FMCG) industry. To determine the extent of interrelated role of e-SCM systems as consumer demand orders cascading upstream supply chain networks in the FMCG industry. If technological characteristics influence the adoption decision of e-SCM systems with increased availability of cost-benefit information sharing system (Walker and Jones (2012:15-28), the greater ability to acquire, assimilate, transform and strategically exploit knowledge and skills should present opportunities and simultaneously indicate the constraints for IT innovation adoption in relation to competition and inter- and intra-organisational relationships (Harrington and Guimaraes, 2005; Wu and Chuang, 2010; Lin, 2014). This paper findings advocate that the BWE in the FMCG industry is mostly generated by lead times in supply chain order replenishment process, and the influence of irrational patterns and decision making among supply chain members coincides with in-house IT systems in restricting the seamless nature of supply chain integration. The template-based information sharing is creating errors in transmitting the demand order upstream along the series of trading supply chain partners. These key components of this study give considerable understanding on the role of electronically enabled-SCM system and possible mitigation mechanism for consumer demand order variability. The empirical evidence of this paper indicated the linear relationship between e-SCM system diffusion and the extent to communicate the organisation’s future strategic requirements throughout the supply chain network. Communicating future strategic requirements and accessing advance economic information across the supply chain network normally depends on integrating an IT system with timely, efficient and transparent supply chain business information. The second predictor variable that should offer greater control and access to advance economic information over demand in the supply chain is negatively related to e-SCM system diffusion. Legally constrained or template-based information prohibits the level of access to advance economic information, despite the extent to which a considerable percentage underpinned technology adaptability using their third-party IT system from industry experts. Although majority of organisations currently has an in-house information technology department either facilitating or carrying out the required supply chain technology solution.

In terms of new dimensions, “Electronic supply chain communication system” describes the supply chain electronic system that enhances trust-based coordination structure, better communication of demand order replenishment requirements for consistent product availability and accelerates physical product and information flow capacity. The paper further attempts to establish discrete dimensional patterns of interrelationships among the oscillating effects of challenges and underlying sets of mitigation strategies. The e-SCM systems diffusion
also depicted positive linear relationship to the extent to which the organisations efficiently and timely communicate the future strategic needs and demand order replenishments throughout the entire supply chain network. The access to advance economic information negatively related to e-SCM systems with the virtue of legal constraints in-house IT systems and template-based information exchange from rational self-optimisation and opportunistic behavior of supply chain partners. In a broader empirical perspective, e-SCM systems diffusion depicted key positive associations with the challenges of bullwhip effect. In a nutshell, the adoption of e-SCM systems has a positive influence and association with bullwhip effect by effectively communicating and actively coordinating the real-time information exchange. The legal constraints and template-based information presented intractable access to advance economic information due to sometimes the elements of partnership trust, security of information flow and complexity of implementation. The in-house IT department (61%) might have a roguish effect on the compatibility of technology solutions and eventually contribute towards instituting information flow security constraints and debilitating the level of trust.

**Discussion Implications**

The electronic linkage for supply-side and demand-side partners indicates a better information sharing communication on inventory positioning to achieve integrated supply chain management processes. The e-SCM systems have the ability to rapidly respond to demand variability and supply changes to reduce supply chain costs and opportunity cost of lost sales. Nevertheless, e-SCM systems have a significant role to play in mitigating the consumer demand order variability in the supply chain network. The e-SCM systems diffusion was highly ranked among the meticulously considered variables to palliate the challenges of bullwhip effect. The mean vectors of e-SCM systems outwitted the mean vectors of information sharing capabilities by providing efficient real-time information exchange, and active communication and coordination to control bullwhip effect. The pooling and sharing of resources and capabilities beyond the levels of superiority, dominance, and inferiority in a supply chain will mitigate the risk and diffusion uncertainty of e-SCM systems. The consolidated benefit will pool the relationship between supply chain partners to exhort the adoption of e-SCM systems, enhance positioning of inventory and elevate customer services. Both an optimal inventory positioning strategy and electronically-enabled information exchange are indispensable in reducing the fluctuations in inventory replenishment and improving supply chain performance (Li, 2013:1907). Although Chong and Zhuo (2014:48) emphasize the improved collaborative structure with suppliers and customers before considering technological structure under development chain management (DCM) integration, the reported benefits of electronic supply chain integrations (E-SCI) (Tai, Ho and Wu, 2010) enables organisations to share real time information seamlessly and reduce the risks of the bullwhip effect (Lee, Padmanabhan and Whang, 2004; Koh, Demirbag, Bayraktar, Tatoglu and Zaim, 2007).

**Managerial Implications**

These dimensions reflect a new perspective in managing and controlling amplification in the consumer demand order variability (DoV) moving upstream supply chain network. This particular study achieved its objective tentatively by incisively developing bullwhip effect dimensions together with efficient optimal mitigation strategies towards ameliorating
demand order variability on the selected FMCG industry. The conceptual patterns depicted relations between the extracted principal three bullwhip effect dimensions using varimax rotation method and their respective sub-components. The empirical evidence in this study confirmed a number of bullwhip effect challenges and the critical role of e-SCM systems, information sharing, optimal inventory positioning and global optimisation strategies. The electronically-enabled supply chain management systems improve effective communication with efficient real-time information sharing and better coordination of supply chain processes with integrated supply chain performance to mitigate bullwhip effect. The frequent adoption and implementation of e-SCM systems allows the compelling migration from in-house IT department to align technology clockspeed with central integrated hub as creation of agile and highly flexible responsive system to changing market requirements.

References


Legislative Initiatives in Governance

Logan Naidoo
Mangosuthu University of Technology, South Africa
lnaidoo@mut.ac.za

Abstract

Talk of State capture in South Africa and allegations that President Zuma’s new cabinet reshuffle has been prompted not so much to enhance service delivery as to enable corrupt dealings has increased public and media focus on governance issues. Currently South Africa has the Company’s Act and the Public Finance Management Act (PFMA); both legislative initiatives designed to constrain ethical governance. However, these have not proven to be of sufficient deterrence. In fact, since the promulgation of these laws State Owned Enterprises (SOE) have been brought into disrepute, with the Public Protector reporting into maladministration at the South African Broadcasting Corporation (SABC), the state broadcaster, and the improper manner for the awarding of tenders at PRASA, which delivers commuter rail services in metropolitan area. Other SOE scandals include the suspension of four executives from ESKOM, the electricity public utility, in March 2015. Only one was reinstated with the other three tendering their resignations after being suspended. Denel, a manufacturer of Defence equipment, was unable to pay its suppliers because it had exhausted its cash reserves. Serious concerns were raised and treasury had to intervene when South African Airways (SAA), the national airline, attempted to restructure a contract with Airbus that would have cost the carrier R1 billion in impairments. At Transnet’s Freight Rail (TFR) an audit report by PwC found prima facie evidence of a senior executive selling Transnet intellectual property to private companies. This paper assesses the efficacy of Company’s Act and the PFMA, briefly examines other measures that have been since taken to encourage ethical governance such as creation of the King Reports, and seeks to determine whether existing provisions are adequate for the proper governance of public organisations. The paper concludes that in a situation where government and organisational leadership is perceived to be corrupt the existing measures are insufficient to promote good governance.

Keywords: governance, ethical governance, leadership, maladministration

Introduction

Talk of State capture in South Africa and allegations that President Zuma’s new cabinet reshuffle has been prompted not so much to enhance service delivery as to enable corrupt dealings has increased public and media focus on governance issues. The unrelenting media frenzy in highlighting the ongoing incidents of corrupt practices by government departments has brought in focus the governance in these institutions and the degree to which it exist.

Currently South Africa has a legislative framework and other initiatives which includes the Company’s Act and the Public Finance Management Act (PFMA); both legislative initiatives designed to constrain ethical governance. However, these have not proven to be of sufficient deterrence. In fact, since the promulgation of these laws State Owned Enterprises (SOE) have been brought into disrepute, with the Public Protector reporting on maladministration at the South African Broadcasting Corporation (SABC) which is the state broadcaster and the South
African Airways, the national airline, are reported to be on the brink of financial collapse, and the improper manner for the awarding of tenders at PRASA, which delivers commuter rail services in metropolitan area. Other SOE scandals include the suspension of four executives from ESKOM, the electricity public utility, in March 2015. Only one was reinstated with the other three tendering their resignations after being suspended. Denel, a manufacturer of Defence equipment, was unable to pay its suppliers because it had exhausted its cash reserves. Serious concerns were raised and treasury had to intervene when South African Airways (SAA), attempted to restructure a contract with Airbus that would have cost the carrier R1 billion in impairments. At Transnet’s Freight Rail (TFR) an audit report by PwC found prima facie evidence of a senior executive selling Transnet intellectual property to private companies which in addition sits with the scrutiny about its multi-billion rand procurements. The combined effect of the above reporting is seen as the cause of economic crisis and state of despair currently being faced by the country that has the added burden of junk status to deal with.

This paper briefly reviews existing legislation such as the Company’s Act and the PFMA. Thereafter the guidelines provided by the King Reports is examined for the provision of proper governance. Against this background the paper argues for the adoption of increased considerations of the precepts of the Acts and the guidelines provided by the King Reports to enhance governance in institutions.

Governance in Context

“Governance refers to ‘all processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organization or territory and whether through laws, norms, power or language.’ It relates to ‘the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions.’ A variety of entities (known generically as governing bodies) can govern. The most formal is a government, a body whose sole responsibility and authority is to make binding decisions in a given geopolitical system (such as a state) by establishing laws. Other types of governing bodies are possible. These include an organization (such as a corporation recognized as a legal entity by a government), a socio-political group (chiefdom, tribe, family, religious denomination, etc.), or another, informal group of people. Whatever form the entity takes, its governance is the way the rules, norms and actions are produced, sustained, regulated and held accountable. The degree of formality depends on the internal rules of a given organization. As such, governance may take many forms, driven by many different motivations and with many different results. For instance, a government may operate as a democracy where citizens vote on who should govern and the public good is the goal, while a non-profit organization may be governed by a small board of directors and pursue more specific aims. In addition, a variety of external actors without decision-making power can influence the process of governing.”

(http://www.jstor.org/topic/governance/?refreqid=excelsior%3A739a1029e8770d2b0cd923c818975ee8.

In keeping with the above description governance is seen as the “... establishment of policies, and continuous monitoring of their proper implementation, by the members of the governing body of an organization. It includes the mechanisms required to balance the powers of the members (with the associated accountability), and their primary duty of
enhancing the prosperity and viability of the organization.”
(http://www.businessdictionary.com/definition/governance.html)

Dassah (2015: 716-717) states that the term governance is derived from the term government which is the manner in which power is used in “managing the economic and social resources for a country’s development”.

In extending the term governance to organisations, “Corporate governance is the way a corporation polices itself. In short, it is a method of governing the company like a sovereign state, instating its own customs, policies and laws to its employees from the highest to the lowest levels. Corporate governance is intended to increase the accountability of your company and to avoid massive disasters before they occur. Failed energy giant Enron, and its bankrupt employees and shareholders, is a prime argument for the importance of solid corporate governance. Well-executed corporate governance should be similar to a police department’s internal affairs unit, weeding out and eliminating problems with extreme prejudice. A company can also hold meetings with internal members, such as shareholders and debt holders - as well as suppliers, customers and community leaders, to address the request and needs of the affected parties.”
(http://www.businessdictionary.com/article/618/why-is-corporate-governance-important/)

According to United Nations (2005), “Fostering effective leadership is perhaps one of the most important and first steps to take... Effective leadership is critical to the future of governance, of democracy and of people’s well-being...” In expanding on this definition Ciulla (2014: xv) is of the view that leadership is “...a complex moral relationship between people based on trust, obligation, commitment, emotion, and a shared vision of the good”. In a moral sense leadership has ethics at its core which then places ethics “...at the heart of all human relationships and hence at the heart of the relationship between leaders and followers.” (Ciulla, 2014: xv)

In common from the above discussion on governance and corporate governance are the terms: process, governing, network, interaction, leaders, leadership, transparency, decisions, management, rules, policies, monitoring, trust and ethics. A working definition of governance would involve the management of people via action, rules and policies that involves a relationship of mutual benefit that is based on trust, transparency and accountability

Legislation in context

Before any discussion on legislative initiatives can be pursued a working definition of legislation is essential. Legislation can be viewed as the act or process of making law or the law itself. (https://www.vocabulary.com/dictionary/legislation)

Legislation is viewed as law that is formulated by “… a governing body in order to regulate, to authorise, to sanction, to grant, to declare or to restrict... defines the governing legal principles outlining the responsibilities ....…” (http://www.londoneventstoolkit.co.uk/legislation/what-is-legislation/)

For the purposes of our discussion legislation may be viewed as laws, rules, procedures and regulations that have been put in place by a body with authority which becomes enforceable through action or lack thereof. In addition and specific to the nature of this paper guidelines provided by reports that seeks compliance will be reviewed.
Public Sector Legislative Framework

The South African Constitution (1996) forms the cornerstone of guidelines for ethical conduct. These guidelines which serve as a Code of Conduct which are provided as ethical principles include the following:

- Promotion of a high standard of ethics and ethical standards
- Services must be provided impartially and without bias
- Public administration must be accountable
- Transparency must be fostered
- Dealings with the public must be free of discrimination
- People must be treated with respect
- Promotion of professionalism in the public sector

The above principles call on public officials to uphold these principles in their own actions and in dealing with others. In addressing the Integrity Leadership Summit Minister for the Public Service and Administration Adv. Ngoako Ramatlhodi pointed towards the high level of corruption as a global challenge that affects both developed and developing countries. In outlining how corrupting is impacting on development he stressed that in order to overcome corruption institutions needed to adopt the precepts of the constitution, “I need not remind you that when the drafters of our constitution came up with this supreme document, they had a foresight that ethical conduct should be one of the cornerstones in the Public Service. As such, Section 195 (1) of the Constitution of the Republic of South Africa requires a Public Administration that is governed by democratic values and principles including among other things promotion and maintenance of a high standard of professional ethics...” (http://www.dpsa.gov.za/article.php?id=494).

In addition to the various Acts that form the legislative framework for promotion of an ethical conduct Lues and Bester (2007) amongst others identify a number initiatives that exist in the Public Service that are crucial for the promotion of ethics and ethical behaviour. Some of these include:

- The National Anti-Corruption Forum
- Moral Regeneration Unit
- Public Service Code of Conduct
- South African Ethics in Practice 2001
- Public Service Handbook

The above, together with a host of other initiatives, have existed in the public Service for well on two decades but have not been successful in the promotion of ethical conduct. This has led to issues on governance not only at leadership level but in the rest of the organisation as well. It therefore becomes necessary to explore other guidelines that may help to improve the current state of unethical conduct and poor governance in public organisations.

Legislative initiatives in Governance

South Africa is said to have a rich vein of legislation for just about anything. This is also true for governance. Besides the Company’s Act and The Public Financial Management Act there
are guidelines provided by the King Reports. This section will highlight some of the provisions in the above mention documents as a narrative to corporate governance.

**Company’s Act and PFMA**

Both the Company’s Act and the Public Finance Management Act (PFMA) are two legislative initiatives that provide legal and regulatory constraints for ethical behaviour. In summary the Company’s Act requires that director’s act in good faith and for proper purpose, in the company’s best interest and with care, skill and diligence. They may not use their position or knowledge obtained through their position to take advantage or harm the organisation. Any information that may harm the organisation needs to be immediately disclosed if they are not legally precluded from doing so. They must take reasonable steps to keep themselves informed, must have a rational basis for making or supporting a decision, but may rely on competent employee, board committee or expert opinion to do so where there’s a reasonable basis for it (Company’s Act. 2008; SAAPAM, 2016)

The PFMA calls on directors to protect the assets and records, act with fidelity, honesty, integrity whilst managing financial affairs, disclose to the minister when requested necessary information, and act in protection of the financial interests of the state. Further that they may not contravene their board responsibilities or the terms of the PFMA, and must in addition to not using their position to benefit themselves or their families, recuse themselves when there is such a conflict of interest. (PFMA. 1999; SAAPAM, 2016).

The Company’s Act and the PFMA although providing adequate direction of the roles of directors in organisations in both the private and public sectors is limited in elaborating on the broad principles it relies on to effect sound corporate governance. To this end the recently released King IV Report provide the necessary guidelines.

**King IV Report**

King IV came into effect from 1 April 2017. It is an extension of King III with emphasis on governance and best practice. Accordingly King IV “… has been revised to bring it up to date with international governance codes and best practice; to align it to shifts in the approach to capitalism (towards inclusive, integrated thinking across the six capitals) and to take account of specific corporate governance developments in relation to effective governing bodies, increased compliance requirements, new governance structures (e.g. Social and Ethics Committee), emerging risks and opportunities from new technologies and new reporting and disclosure requirements e.g. Integrated Reporting. “


It is important to note that King IV like its previous reports “… is voluntary (unless prescribed by law or a stock exchange Listings Requirement) it is envisaged that it will be applicable to all organisations irrespective of their form or manner of incorporation. The King Code™ principles of good governance are presumed to apply, whilst the practices should be applied on a ‘proportionality’ basis depending on the nature, size and complexity of the organization.”

King IV “... places accountability on the governing body (e.g. the board in companies) to attain the governance outcomes of an ethical culture, good performance and effective control within the organisation and legitimacy with stakeholders. King IV™ aims to reduce the ‘tick box’ or compliance approach to applying governance practices.”


In terms of the above King IV becomes self-regulatory in that it provides organisations with the guidance in which to develop an internal culture of governance. It “… has the following elements: practices, principles and governance outcomes. The practices are recommended at an optimum level of corporate governance and should be adapted by each organisation to achieve the principle. The governance outcome is the positive effect or benefits of good corporate governance for the organisation and includes ethical culture, performance and value creation, adequate and effective control and trust, good reputation and legitimacy.” In essence King IV is focused around the following:

- “Ethical and effective leadership
- Company’s role and responsibility in society
- Corporate citizenship
- Sustainable development
- Stakeholder inclusivity and responsiveness
- Integrated reporting and integrated thinking”


**King IV Corporate Governance Principles**

King IV provides a set of principles which if adhered to will help in the journey towards good corporate governance. The role and responsibilities of the governing body includes: the steering and setting of strategic direction, the approval and planning of policy, overseeing and monitoring, and ensuring accountability. These roles and responsibilities are guided by the following principles: (IoDSA King IV Report, 2016)

- “The governing body should lead ethically and effectively.
- The governing body should govern the ethics of the organisation in a way that supports the establishment of an ethical culture.
- The governing body should ensure that the organisation is and is seen to be a responsible corporate citizen.
- The governing body should appreciate that the organisation’s core purpose, its risks and opportunities, strategy, business model, performance and sustainable development, are all inseparable elements of the value creation process.
- The governing body should ensure that reports issued by the organisation enable stakeholders to make informed assessments of the organisation’s performance and its short, medium and long-term prospects.
- The governing body should serve as the focal point and custodian of corporate governance in the organisation.
- The governing body should comprise the appropriate balance, skills, experience, diversity and independence for it to discharge its governance role and responsibilities
objectively and effectively.

- The governing body should ensure that its arrangement for delegation within its own structures promote independent judgement, and assist with balance of power and the effect discharge of its duties.
- The governing body should ensure that the evaluation of its own performance and that of its committees, its chair and its individual members, support continued improvement in its performance and effectiveness.
- The governing body should ensure that the appointment of, and delegation to, management contribute to role clarity and effective exercise of authority and responsibilities.
- The governing body should govern risk in a way that supports the organisation in setting and achieving its strategic objectives.
- The governing body should govern technology and information in a way that supports the organisation setting and achieving its strategic objectives.
- The governing body should govern compliance with applicable laws and adopted, non-binding rules, codes and standards in a way that supports the organisation being ethical and a good corporate citizen.
- The governing body should ensure that the organisation remunerates fairly, responsibly and transparently so as to promote the achievement of strategic objective and positive outcomes in the short, medium and long term.
- The governing body should ensure that assurance services and functions enable an effective control environment, and that these support the integrity of information for internal decision-making and of the organisation’s external reports.
- In the execution of its governance role and responsibilities, the governing body should adopt a stakeholder-inclusive approach that balances the needs, interests and expectations of material stakeholders in the best interests of the organisation over time.
- The governing body of an institutional investor organisation should ensure that responsible investment is practiced by the organisation to promote the good governance and the creation of value by companies in which it invests.” (IoDSA, 2016)
- The benefits of the governance outcomes that an organisation could realise according to King IV is an ethical culture, good performance, effective control, and provide legitimacy. (IoDSA, 2016)
- In clearly identifying its underpinning philosophy as addressing ethical effective leadership, it speaks of an ethical ‘culture’, ‘consciousness’ and ‘behaviour’. In taking this approach it suggests that an organisations culture is set from the top and that the behaviours of leaders influence those that they lead. (Naidoo, 2017; SAAPAM 2017)

**Ethical Leadership**

Various authors have given meaning to ethics in leadership or ethical leadership. These definitions at the end contribute to a clear thinking on the elements that are so vital towards achieving sound corporate governance as highlighted in the Act and guidelines provided in the above discussion.

Leadership is viewed as “a complex moral relationship between people based on trust, obligation, commitment, emotion, and a shared vision of the good” and ethics “… is about how we distinguish between right and wrong, or good and evil in relation to the actions,
volitions, and characters of human beings.” and lies “at the heart of all human relationships and hence at the heart of the relationship between leaders and followers.” (Ciulla, 2014:xv). Expanding on the ethics component of leadership Ken Parry and Ardu Fiskerud suggest ‘... that office bearers, whether political, social or commercial, are vested with power and that with the privilege that power confers ethics becomes a responsibility.’ (Parry and Fiskerud, 2015:98. Also see Naidoo, 2016). Kruze (2013), posits “Leadership is a process of social influence, which maximizes the efforts of others, towards the achievement of a goal.”

South African views have not been seen as being dissimilar to the ones expressed above, for example, the Public Protector sees a need for “... ethical leadership to raise the bar regarding integrity in public sector service delivery” and “Integrity applies with respect to both the manner in which people are treated and control over public resources and opportunities is exercised.” (Madonsela, 2012). Integrity management system for organisations is viewed as those organisations that would have integrity controls that include rules, codes of conduct, ethical principles, etc. (Malunga, 2015:8).

Chief Justice Mogoeng Mogoeng is quoted as stating that ethical leadership is a ‘national imperative’ and was of the opinion that unethical leadership that led to forced removals, job reservation and the other ills of apartheid and that ethical leadership in the government and the corporate sector was needed to rectify the injustices of the past. He stated; “When you are a leader, you have the authority to influence those you lead and it is what you do that largely determines what those who follow you are likely to do.” (Mogoeng, 2016).

However simply recognising that ethical leadership is necessary and even incorporating integrity systems, strategies and plans in organisations does not guarantee that a change in organisational culture will result. There is a recognition that what is needed is behavioural change; “Companies from Enron to The News of the World had a strategy. Unfortunately the tone allowed a corporate culture to develop that ultimately overwhelmed any chance of the strategy succeeding. And that is why I believe behaviour trumps strategy.” (Muir, 2015:3). Once it is acknowledged that behavioural change is at the heart of promoting ethical leadership the questions then becomes; how can organisations constrain behaviour? Rules and regulations although necessary are only found to be partially effective and actually “…corporate compliance policies and laws do not seem to be having the desired influence on eradicating unethical leadership. The US designed new financial policies and practices following the Enron collapse, yet these new rules and laws did not prevent the same practices being used prior to the global financial crisis.” (Branson and Gross, 2014:2). An even clearer statement is made by Elizabeth Stapp, Kevin O’ Brien and Stephen Martin II (2012:120-129); “Laws can do only so much. While taking the cue from the new regulatory environment, executives nonetheless must choose the path of ethical leadership.” So what tools and mechanisms exist that can assist leaders to ‘do the ethical thing’? (Naidoo, 2017)

Cynthia Schoeman in expanding on the views of others suggests that a code of ethics is necessary. Organisation’s code of ethics should include “values, its code of conduct, and other supporting policies for ethics-related matters” (Schoeman, 2014:99). It is interesting to take note of her view that ‘ethics needs to eventually move beyond rules and a largely rule based approach to be truly effective’ (Schoeman, 2014:203).
In summary corporate governance is viewed as “a product of both compliance (legal and regulatory constraints) and integrity (the internal culture and self-regulatory environment).” (Seawell, 2012: 17). It is in this context that King IV, as a set of voluntary codes to enable effective, efficient and ethical corporate governance, becomes significant. (Also See: Naidoo and Naidoo, 2016)

King IV Promoting Ethical Leadership

One of the important components of corporate governance is about ethical leadership. In unpacking the above principles, it can be seen that King IV covers the principles of responsibility, accountability, fairness and transparency. This it does by directing the manner in which the governing body of an organisation should conduct itself to effect ethical leadership. It states:

“Responsibility: The governing body should assume ultimate responsibility for the organisation, as well as the protection of resources: financial, manufactured, human, social and relational, and intellectual and natural capitals.

Accountability: The governing body should be held responsible for its decisions and actions by stakeholders. Accountability follows from the assumption or designation of responsibility. Governance structures and arrangements should connect responsibility and accountability. Accountability cannot be delegated or abdicated, and should be communicated clearly.

Fairness: The governing body should ensure that it balances in its decisions the legitimate and reasonable needs, interests and expectations of material stakeholders of the organisation, in the best interests of the organisation.

Transparency: The governing body should ensure that reports and disclosures enable stakeholders to make an informed assessment of performance, including the impact of the organisations activities and its ability to sustain creation of value.” (King IV, 2016. Also see Naidoo, 2017)

In engaging especially in these four principles King IV provides clear guidelines to organisations and leadership the need for integrity in the management of people.

As can be seen King IV is an important contribution to corporate governance notwithstanding the fact that it is a set of guidelines and remains as such, there is a sprinkling of these guidelines both in the Company’s Act and the PFMA. There might be some debate on who owns the common (or sprinkling) of guidelines that already appear in the Acts but there is no doubt the King IV is a vital contribution to good corporate governance and must be seen as essential to providing the necessary direction for bodies/agencies to uphold through the leaders of organisation sound ethical corporate governance.
Evidence of Effectiveness of King IV Recommendations

The recommendations contained in King IV are fairly comprehensive and numerous public organisations have already instituted some of these measures after they were alerted to unethical practices within their organisation. The continuous reporting of several cases of fraud and other corrupt practices, some of which are mentioned in this paper, highlight the fact the legislation and guidelines on their own are not sufficient.

Conclusion

King IV provides guidance on organisational policies, practices, functions and capabilities that when implemented can fundamentally change organisational processes to proscribe unethical practices and promote ethical behaviour. The intent is to have the demonstrated behaviour and reformed processes change the organisational culture so that at every level personnel identify and weed out unethical behaviour amongst their peers and personally aspire to the highest standards of integrity. However as stated in the discussion King IV remains a set of recommendations which if not given legitimacy cannot help to stem the corrupt and unethical behaviour alluded to in the earlier discussion. In order to enhance its application organisations would do well to apply the King IV principles together with the existing legislation on corporate governance proved by the Company’ Act and the PFMA.

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Abstract

Diabetes mellitus (DM) is a chronic disease that is on the rise worldwide. Statistics show that the number of people between 20 and 79 years, who are affected by Diabetes, will reach 439 million (7.7%) by 2030. This is a projected growth of 69% in developing countries and 20% in developed countries from 2010.

The findings from studies conducted from 1993 to 2003 in Sub-Saharan Africa, particularly in South Africa, around the health care services for diabetes highlights many challenges. Sadly, the challenges 10 years after that study, are very similar. The conditions of people with Diabetes can be improved through regular monitoring of patients, improvement and monitoring of health care provided, education on healthy lifestyle, as well as education on the importance of adherence to treatment plans for the successful management of the condition. The diabetes endemic in South Africa is exacerbated by the manual functions that are performed in all aspects of monitoring and management of the disease. With the advancements that have been made in ICT and the many apps that already exist for healthcare, it will be sensible to state that ICT can assist in the monitoring and management of diabetes.

The need to incorporate e-health into governments’ healthcare plans has been growing over the last decade. The GSMA conducted research into mobile health opportunities in South Africa and found that with a mobile penetration rate of 98%, it is the ideal medium to address the inaccessibility and inequality of healthcare in South Africa.

Bearing this in mind, this study has investigated the needs and care plans for people with diabetes. Specialist in the field of diabetes were interviewed and recognized care plans for diabetes such as those from World Health Organization (WHO), International Diabetes Federation (IDF) and Society for Endocrinology Metabolism and Diabetes of South Africa (SEMDSA) were studied. The causes identified as playing a major role in the rise in diabetes were identified and it was determined that, through the implementation of an ICT strategy for diabetes care, many of these can be addressed. This paper will focus on the self-management aspect of diabetes and will make recommendations with regards to the daily self-management aspects of diabetes care whilst using mobile technology as part of an ICT Strategy for self-management.

Keywords: mHealth, diabetes self-management, mobile technology, health informatics

Background

The World Health Organization (WHO) defines non-communicable diseases (NCDs) as diseases that are not passed from person to person. NCDs are also known as chronic diseases which means that they have a slow progression and a long duration. Non-communicable diseases also have a direct impact on the disease burden as they often cause multiple or compounded problems in patients who already require chronic care (Mayosi, et al., 2009). The major NCDs
are listed by the Human Research Council as cardiovascular diseases, diabetes, chronic respiratory condition as well as cancer. These NCDs share the same modifiable risk factors, namely: tobacco use, physical inactivity, unhealthy diets and harmful use of alcohol.

The South African landscape shows the same statistical pattern as the global trend with regards to NCDs, namely, that cardiovascular diseases are the most prevalent, followed by cancer, diabetes and respiratory disease (Human Science Research Council, 2013). South Africans are getting lifestyle diseases in their 40’s and 50’s, and many are untreated and undiagnosed, and consequently dying prematurely (Child, 2012). Furthermore, with urbanization comes a change from the normally active lifestyle in rural areas, to a more sedentary lifestyle and fast-food diet that increases the chances of obesity (Stassen, 2014). Rotherum-Borus (2012) states that 2.6 million people were affected with diabetes in South Africa in 2012. Statistics also show that diabetes is the second-highest cause of deaths in people above the age of 45 (Statistics South Africa, 2013). Diabetes therefore has a major impact in the disease burden of the country.

Recent data have indicated a decline in the number of HIV/AIDS mortality rates, and a longer life expectancy for people with HIV/AIDS, because of the successful implementation of an anti-retroviral program in South Africa. This is in contrast with diabetes that is on the increase, due to the ageing population and the risk factors associated with diabetes also being sharply on the rise (Levitt, et al., 2011). The South African government drafted national guidelines for the management and control of NCDs (National Department of Health, 2006) and recognised the impact that diabetes has on the disease burden of the country. However, barriers such as the lack of dissemination, monitoring, assessing the management and control of chronic disease, and then lack of adequate skills of clinic staff to deal with NCDs, were identified by Mayosi (2009) as factors that hampered the implementation of the guidelines. According to Daan du Toit (2012), Senior SA Science and Technology representative to the European Union (EU), the Medical Research Council (MRC) has targeted diabetes as its number-one NCD priority for intervention; and it is looking at focusing one of their research areas on the effects of lifestyle, specifically diet, from pre-natal to adulthood on Type 2 Diabetes.

The focus of this study is Type 2 diabetes in the South African context with the aim of aligning it with the South African government’s goals and to assist in lowering the impact of diabetes on the disease burden of the country as it is a preventable condition.

The use of information communication technology (ICT) to assist in improving healthcare has been on the rise for many years. Kahn et al. (2010) states that non-communicable diseases require special care strategies and complex solutions such as early, broad-based community interventions (due to the long dormancy period of chronic illnesses), behavioural and lifestyle changes, complex strategies and multiple ongoing care, chronic medication (which add cost implications) and self-care requirements. These strategies could benefit from the use of ICT; as this technology can be accessed over large geographical areas; and educational or relevant text messages can be sent to encourage lifestyle changes; the internet can be accessed for health tips and advice; emails can be used to strengthen communication and help with continuous interaction; and reminders can be sent for prescription renewals and the collection of medicines (Kahn, et al., 2010).

This paper therefore identifies ICT strategies that can bring these advantages to people with diabetes in South Africa.
Literature review

A review of the literature has shown that there are many barriers with regard to implementing ICT strategies to solve healthcare issues in developing countries. Non-communicable diseases (NCDs) are also adding to the disease burden of these countries. South Africa is not without its own problems in these areas. These include lack of funds, vast rural communities, poor access to healthcare, and a quadruple disease burden. Diabetes is not only a NCD, but it is also growing at a disproportionate rate, causing premature, in fact avoidable, deaths. ICT interventions are piloted but rarely grow to maturity and most often do not continue once the study is concluded.

The ITU World Telecommunication (Sanou, 2015) released its facts and figures on ICT globally in 2015. This report shows that the Mobile broadband is the most dynamic market segment; and penetration reached 47% globally in 2015. This is a 12-fold increase on the 2007 figures. In Figure 1 the global developments in ICT have been captured. The two lines that stand out are the one indicating the increase in mobile-cellular subscriptions and the other indicating the sharp increase in mobile-internet subscriptions.

It is clear from the graph that one of the most disruptive technologies since the advent of the internet is that of mobile technology.

The financial implications of technology use in healthcare have been carefully studied; as initial indications were that this would not be viable, due to the high cost of the technology involved (Istepanian, et al., 2004). However, the cost of technology has decreased over the years making devices, such as cell phones, affordable – even to the poorest (GSMA, 2012). Research suggests that there are four major factors that drive healthcare cost increases worldwide, namely ageing population, medical procedure cost, resource constraints and patient empowerment (McKinsey and Company, 2010; Congdon, 2013). Since developing countries have an ever-increasing number of chronic diseases, this implies that the disease burden for these already-battling economies would have the potential to cripple the country completely.

Research statistics from the McKinsey and Company Report (2010) indicates that the healthcare sector needs to embrace technology in the same way that other business sectors have, in order to attain the many benefits that come with it. The use of technology promises many benefits for the healthcare sector. GSMA (2010), Schweitzer & Synowiec (2012) and Congdon (2013) list some of the benefits as:

![Global ICT developments, 2001-2015](image)

*Figure 12: ITU report for Global ICT growth  Source: (ITU: Development, 2015)*
• Improved communication with patients;
• Better service at clinics as less face-to-face visits are required;
• Closer contact with healthcare practitioners;
• Improved patient access to quality healthcare;
• Closer monitoring of patients with regard to early warning systems for deteriorating conditions;
• Earlier diagnosis;
• Eliminates need for frequent clinic visits;
• Benefits to the society;
• Improved life expectancy;
• Quicker diagnostics of potential epidemics and management of associated risk;
• Better insight into the causes of certain diseases;
• Greater and quicker information-sharing to identify appropriate treatments;
• Reduced absenteeism from work.

The study described in this paper, was motivated by the lack of a strategy that is designed to help people with diabetes manage their chronic condition effectively by using the ICT available to them. The purpose of the study was to identify a strategy that does not require significant financial investment from government or other external sources in order for the strategy to be implemented.

This strategy would empower those affected by diabetes in that it would not only assist with self-management of the disease, but it would also have a component to improve diabetes awareness and education. The strategy should be implemented using the available ICT infrastructure and it must be focused on mobile devices so that the person with diabetes is using a familiar device and also has the security of having access to the device at all times.

**Methodology**

Under the umbrella of Design Science Research, the main study employed a comprehensive literature review with regards to the health care sector in South Africa, diabetes and strategy formulation. Semi-structured interviews were conducted with experts in the field of diabetes. Recognised diabetes treatment plans and requirements were studied including those of the Society of Endocrinology, Metabolism and Diabetes of South Africa (SEMDA), the International Diabetes Federation (IDF) and the World Health Organization (WHO). Design science aims at developing an artifact which can provide technology based solutions to social problems in a specific context. In the main study, design science was used to develop a strategy to solve the problems in the diabetes self-management sphere. This paper focusses on the self-management aspect within the main study.

Apart from the literature study, a total of nine semi-structured interviews were held with experts in the field of diabetes. The participants were drawn from the public as well as the private health care sector. The participants incorporated a diverse range of medical fields, due to the nature of care required for people with diabetes. Participation was also drawn from health sciences in respect to the academic sphere. The interviews varied between 45 minutes and 2 hours depending on subsequent questions or matters that arose requiring noting. Most interviews were conducted face-to-face but some were also telephonic.
For the purpose of analysis each participant was given a code identifier to protect their identity. The code identifier was used for frequency counts as well as to identify specific areas of concern raised by a particular individual that would require further investigation. From the analysis there merged clear themes and key factors that would form the basis for the study. These included challenges and requirements of diabetes people, as well as ICT availability and barriers. The data findings from the semi-structured interviews were also compared to the requirements and findings of the literature studies to ensure comprehensiveness.

**ICT strategy for self-management**

The strategy formulation for the study investigated strategy approaches such as those of the Saylor Foundation (2013), Daft (2003) and Goldman and Nieuwenhuizen (2006). An adaptation of these strategies was used to formulate the ICT strategy, as consideration was also given to requirements that are specific to ICT strategies. The strategy processes that were followed to develop the ICT strategy for diabetes care are depicted in Figure 2 as Phase 2. Specifically, phases 2 and 3 refer to the diabetes and ICT requirements after initial investigations were concluded as required by design science principles in the overarching study.

![Figure 2: ICT strategy formulation steps](image)

Phase 2 requires an in depth study of the problem, finding the guiding policies that relate to the problem and creating the coherent actions to take in order to implement the solution (strategy). One of the areas identified requiring an ICT intervention was that of self-management of diabetes. The strategy design was used to discover the challenges with regard to self-management of diabetes and lay the guiding policies down for addressing these challenges. The action plans were drawn up to support the guiding policies. Sections 4.1, 4.2 and 4.3 will outline the details of the formulation process.

**Guiding Policies**

Guiding policies are the broader solution to the problem that has been diagnosed (Rumelt, 2011). In order to ensure that the guiding policies met the requirements for diabetes care, recognised diabetes treatment plans and requirements were studied including those of Society of endocrinology metabolism and diabetes of South Africa (SEMDSA), International diabetes federation (IDF) and World health organisation (WHO).
The fist column of Table 1 outlines the problems that were diagnosed and suggestions as to how the problem can be overcome. The second column indicates the guiding policy for the problem diagnosed.

Table 2: Problem diagnosis and corresponding guiding policy

<table>
<thead>
<tr>
<th>Problem Diagnosis and Suggestion</th>
<th>Guiding Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of knowledge and awareness about diabetes was cited as one of the major factors contributing to the rise in diabetes prevalence. The available technology at hand for people with diabetes can be used to educate them on diabetes risk factors as well as the importance of treatment adherence.</td>
<td>To use available technology to educate people on diabetes, lifestyle and the importance of adherence to the treatment program</td>
</tr>
<tr>
<td>Lack of communication between the patient and the healthcare worker leads to a poorer service delivery and poor adherence to treatment, which in turn can lead to major complications. Patients and healthcare workers are often geographically dispersed making frequent visits or emergency consultations very difficult. Using the existing infrastructure and technologies at hand can alleviate the communication problem leading to increased service delivery and ultimately reduce the disease burden.</td>
<td>To improve communication between patient and healthcare workers using available ICT</td>
</tr>
<tr>
<td>Challenges, such as internet access, mobile phones and the lack of computerization in the healthcare sector point to problems with access to ICT and also forms a barrier when attempting to use technology to alleviate problems in the healthcare sector. The guiding policy uses available technology to support self-care management of diabetes. The technology available at the point of treatment is what is used to support people with diabetes. The guiding policy aims to maximise the use of the already existing mobile devices.</td>
<td>To use ICT available to people with diabetes to its full potential</td>
</tr>
</tbody>
</table>

The mobile technology strategy to support self-management of diabetes

The use of mobile technology to support self-management of diabetes strives to assist people with diabetes to make full use of the mobile devices that are at hand for their diabetes care. The strategy was guided by the process as depicted in Figure 2. Rumelt (2011) states that the strategy formulation is the “kernel” to solving a problem. Prior to developing the actual strategy, it is important to understand the challenges that are faced by people who have diabetes. These challenges are in respect to diabetes itself as well as to access to ICT. It is necessary to identify the critical aspects through diagnosis of the environment and understanding the situation as a whole. Challenges that were identified during this study include:
Lack of diabetes knowledge and adherence to treatment plan

The semi-structured interviews indicated that people with diabetes do not only lack knowledge about diabetes itself, but also lack the knowledge as to what leads to the onset of diabetes. People are also not aware that this is a lifelong condition that they need to manage every single day for the rest of their lives. Furthermore, they do not keep up with their treatment regime as they stop medicating when they “feel better”.

Lack of continuous communication with healthcare workers

The South African healthcare system is understaffed and faces many challenges. People with diabetes need to visit the clinic or hospital at regular intervals but often do not do so due to the long queues and delays at these facilities. They would then only go when they need medication or have an emergency. There is also no way of communicating easily and speedily with a healthcare worker regarding their glucose results, and this could lead to complications and even death.

Lack of use of mobile devices (ICT) by people with diabetes

The diagnosis with regards to access to information communication technology indicates that the majority of people with diabetes have access to a mobile device. However, the diagnosis also reveals that they are not making use of these devices to assist them in adhering to their treatment plan, obtaining diabetes education or communicating with their healthcare workers.

Action plan

According to Rumelt (2011) a set of coherent actions are the exact steps, policies, resources commitments and actions that are designed to facilitate the guiding policies. These are the actual actions that must be taken by the various role players, in order to transform the goals into actionable objectives. In order to ensure that the action plan met the requirements for diabetes care, recognised diabetes treatment plans and requirements were studied including those of SEMDA, IDF and WHO.

The action plans are patient-centred and considers what the patient has at hand and adapts to that level of technology intervention.

Determine level of ICT technology and access available to patients and healthcare workers

The technology available to the healthcare worker and the patient are interdependent on one another; and as such, the first action plan to follow is that of determining the level of interaction possible between the healthcare worker and the person with diabetes. In all instances of using this strategy the first port of call will be this step that requires the identification of the technology at hand. This refers to the technology that the person with diabetes has available, as well as the technology at the point of treatment. It is important to note that the level of technology does not prescribe to the action plan itself, but rather to the steps within the plan.

Continuous diabetes and lifestyle adherence education

Diabetes education can take the form of any of the recommended ICT interventions; but firstly, there needs to be a commitment to this step from the patient. The steps to follow for the use of ICT for diabetes education will help to ensure successful implementation.
It is important to firstly determine the level of technology available to the patient and the carer. Once it is established that the clinic/carer is available to assist with diabetes education an agreement should be entered into that indicates the patient’s commitment to the program as well as outlines the requirements from the patient. This can be in a form of a pledge or letter of compliance. It is important that the patient access the required educational materials and also keeps a log of the material used. This log can assist the healthcare worker in keeping track of the patient’s education activity.

The type of educational interventions that can take place could be in the form of SMSes, pictures, voice messages and video clips. These interventions can cover simple general diabetes facts, lifestyle tips and exercise suggestions. Hyperlinks to trusted diabetes education, and lifestyle and fitness sites can also be shared. Chat groups can be set up whereby peer encouragement and motivation can be shared. Chat groups can also be set up amongst those in similar geographic areas and local diabetes awareness events and functions could be shared. These groups can be created on cell phones or as email groups depending on the technology available. These examples are not exhaustive, but merely serve to give an idea of the type of intervention that can be employed to encourage the patients to use ICT for diabetes education and awareness.

**Improved communication between patients and the healthcare worker**

Communication between the patient and the healthcare worker is essential to the management and monitoring of diabetes. The level of intervention possible will be determined by the technology available.

Once the level of technology available has been determined it should be logged on the patient’s record. The patient should be informed of how the technology intervention can assist in diabetes care. The patient must also understand the requirements, expectations and rules of engagement, so the patient is aware of his/her role/responsibility in the technology intervention. The patient must give permission to engage in the technology intervention and also sign a pledge of commitment to using technology, as part of the treatment plan.

Table 2 depicts a list of examples of possible communication interventions. This serves only to give some initial ideas to help the healthcare workers improve communication with the patients.

**Table 3: Ideas on how to improve communication with healthcare workers**

| SMS communication must be used for regular feedback regarding glucose levels (daily); |
| SMS communication must be used for irregular/abnormal glucose levels, in order to provide immediate assistance (as required); |
| SMS communication can be received for educational/motivational messages (daily); |
| Reminders can be created to ensure that the medication is taken and blood glucose monitoring is done (daily); |
| Reminders can be set up; so that follow-up visits are not forgotten/ignored (as required); |
| Voice messaging can be used for feedback to carer (weekly); |
| Video clips teaching patient about diabetes care, such as how to inject insulin, or what type of food to avoid, can be received from the carers (monthly); |
Groups can be formed for disseminating educational messages and the promotion of awareness campaigns (as required).

Summary
From the data collection, it is clear that there are many advantages to ensuring that people with diabetes use the devices at hand to support an ICT intervention that aids in the self-management of diabetes. Table 1 (McKinsey and Company, 2010) is adapted to show the comparison of diabetes care with and without an ICT intervention. The advantages of using ICT to support the self-management of diabetes care are evident and this paper aimed at indicating viable solutions to put ICT at work for the benefit of people with diabetes.

Table 4: Comparison of traditional diabetes care and diabetes care employing an ICT intervention

<table>
<thead>
<tr>
<th>From Traditional Healthcare delivery</th>
<th>ICT in diabetes care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient visits the doctor or hospital, taking time off from work when he/she feels serious symptoms</td>
<td>Patient can communicate with caregiver using own device regarding unusual measurements or emergency</td>
</tr>
<tr>
<td>Doctor interviews patient in person and conducts a typical hands-on examination</td>
<td>Healthcare practitioners can send text messages or voice messages in response to captured blood glucose measurements shared via the diabetes patient’s device</td>
</tr>
<tr>
<td>Doctor prescribes medicine and hopes patient takes it at prescribed times</td>
<td>Healthcare practitioners can send text reminders regarding medication and visits, or follow up to encourage adherence to treatment plan</td>
</tr>
<tr>
<td>Patient gets well and goes back to potentially unhealthy lifestyle</td>
<td>Patients can be monitored more closely and their diabetes management can be aided by lifestyle education and awareness through their own mobile technology devices</td>
</tr>
<tr>
<td>Chronic shortage of (specialized) medical talent thus no expert to educate patients</td>
<td>Patient can get educational information via technology on hand</td>
</tr>
</tbody>
</table>

Conclusion
This paper has endeavoured to identify the challenges underlying the use of ICT to support people with diabetes in the self-management of their condition. The factors affecting the use of ICT to support self-management in diabetes are lack of funds to create an ICT infrastructure and lack of access to technology. The challenges that relate to the increased prevalence of diabetes include factors such as lack of adherence to treatment plans and lack of diabetes knowledge and awareness. The proposed use of mobile technology to support self-management of diabetes addresses these challenges adequately. The lack of funds and access to technology is circumvented by using the technology at hand to patients and healthcare workers at the point of treatment. Having access to mobile technology such as cell phones or smart phones, supports the access to educational material as well as communication with
healthcare workers. This in turn avoids escalating risk factors and possible death, caused by diabetes.

References

Enhancing Public Understanding of Science Through Information and Communication Technologies – A Case Study of Mauritian Students

Hemraj Ramsurrun, Aman Kumar Maulloo
Rajiv Gandhi Science Centre, Mauritius

Abstract

The purpose of this case study is to gather evidence on the expected positive impact of Information and Communication Technologies (ICT) to enhance the public understanding of science and technology in Mauritius given that our scientific and digital literacy level has not been properly assessed and perceptions about science and technology are not well established. Moreover, there is also little evidence on the positive impact of ICT in our education system.

A group of Grade 9 students, equally divided between boys and girls participated in this exercise at the Rajiv Gandhi science Centre. The newly designed “Chemical Weapon Convention” corner and the popular “Science of Sports” exhibitions have served as experimental platforms. In broad, the students consisted of a mixed background (religious, intellectual, financial, family). They were requested to visit and interact with the chosen exhibits prior to the start of the exercises which consisted of three parts. Firstly, a multiple choice treasure-hunt questionnaire was used to determine if ICT-based understanding of science and technology is more effective compared to panel-based reading. Secondly, based on the Technology Acceptance Model (TAM1), an insight of our students’ interests and acceptance of ICT as a tool for understanding scientific concepts was obtained, and thirdly, a survey was carried to establish whether students have a preference for interacting with ICT based exhibits in a science centre or science museum.

It was found that ICT-based exhibits are more conducive to the understanding of scientific concepts. Students have had a better retention of scientific knowledge after interacting with ICT based exhibits. Secondly, there is a strong belief among our Mauritian students that ICT will be useful to enhance their understanding of science and finally, there is a high probability that, among various types of exhibits, students will prefer to interact with ICT-based exhibits which includes devices like tablets, consoles, displays and touchscreen personal computers.

Keywords: public understanding, science, technology, information and communication, Technology Acceptance Model

Introduction

Scientifically literate citizens, who understand the role of science and technology in their lives, are more capable to discuss science in the media, evaluate public policies, analyze risks and benefits of scientific advances and make evidence based decisions (Bell & Lederman, 2003; Holbrook & Rannikmae 2009). Worldwide, science centres and science museums have, since the beginning, been instrumental in raising the scientific literacy of our population to a level favorable for socio-economic development.
Unlike the formal education system, science centres have rather adopted the constructionist approach where the learning process is centred around play, exploration and engagement. Visitors of science centres and science museums are given the opportunity to interact with exhibits while entertaining and educating themselves in the subject matter. The development of these exhibits cuts across various fields and has evolved over the years to include state-of-the-art technologies like Information and Communication Technologies (ICT) which is now taking ground as a popular medium for experiential learning.

With the advent of the ever-growing Internet, ICTs have created a new revolution to give a new shape to the future of mankind and the global community. Today, ICT permeates many different industries and is responsible for the growth of production and revenue (Basu and Ferald, 2008). With the vertiginous speed and facility at which data and information can be exchanged, ICT is transforming the world into a global village facilitating international trade as well as providing cost-effective solutions to business.

Participatory activities involving ICT is pervading science centres to afford plenty of space for research on the deployment of ICT to enhance the public understanding of Science. Mauritius, having accommodated only one science centre for its 1.3 million population, has little data and evidence on the positive impact of ICT on the public understanding of Science.

“Most of the fundamental ideas of Science are essentially simple and may, as a rule, be expressed in a language comprehensible to everyone” – Albert Einstein

There have been several interpretations of scientific literacy. The scientifically literate person, in principle, is able to understand and communicate about science relevant to its society and environment in general. The level of scientific literacy of individuals significantly affects development in the society (Laugksch, 2000), (Adubifa, 2003) and the growing of scientific literacy leads to economic growth and social stability at political and social levels, (Bidokht & Assareh, 2011).

Public Understanding of Science and Technology is a field which has emanated from various expert groups who have delved into the science-society interaction. Public Understanding of Science & Technology in the Mauritian context revolves around Rajiv Gandhi Science Centre (RGSC) and the various activities it conducts. In fact, the RGSC is the only institution, mandated for the promotion and popularization of science and technology in the Republic of Mauritius. A wide range of exhibits exist in its six indoor thematic galleries and the outdoor science park. While some are mechanical, others comprise electrical and electronic circuits. Around 35 % contain an ICT component (computer, television, projector, tablet, digital games). Some exhibits are purely panel-based.

The RGSC has been rigorously organising and conducting various types of activities to impact on the scientific literacy level of the Mauritian population. Inaugurated in 2004, this centre, has since then, targeted people from all walks of life. The student community has been and remains the main target, but activities have also been geared towards educators (pre-primary, primary and secondary), women, senior citizens, persons with disabilities, professionals in science and technology and other groups. Our National Science Week and the famous Science
Quest are the flagship events of the centre. The National Science Week is a national campaign where all the stakeholders unite themselves under one umbrella to disseminate scientific knowledge to the general public. The Science Quest is a national project-based competition for our teens to delve into science and technology, conduct research and develop projects. Other popular activities of RGSC are night Sky Observations and Kiddy Science Fair. Apart from local collaborations, the centre is partnering with international institutions like Questacon, The National Science and Technology Centre of Australia, the National Council of Science Museums, India, and Cape Town Science Centre, South Africa. Fortunately enough, we note an interest of other local institutions to engage the public in S&T. As an example, among many others, the Central Water Authority celebrates the World Water Day every year by setting up a free exhibition on water, its social, scientific and environmental implications.

This year, the RGSC has launched its Strategic Plan 2017-2030 which relies on six pillars to enhance the promotion and popularization of S&T in Mauritius. One of these pillars is the E-promotion of Science and Technology in Mauritius which is essentially a vision for the promotion of science and technology through ICT, be it social networks, web-based technologies, virtual and augmented reality, mobile applications etc. Although, this journey of promoting science and technology through ICT has already started since the operation of this centre, we have to admit that we are still at a very low-speed and lagging behind as compared to other science centres/museums. This situation calls for the adoption of new strategies.

However, the scientific literacy level is not known and perceptions about science and technology is not well established. We have to admit that the field of promotion and popularization of science and technology has not been given any consideration by the research community. Factors which attract people towards or repel them from science, are still vague, although several ideas have been put forward. There is little evidence in this matter. Much in the same situation, with the infiltration of ICT in the everyday life of the Mauritians, there is necessity to ponder on our digital literacy level. In general, digital literacy is considered as the ability to work with computers or ICTs. It is merely the basic skills required to be active on social media, share data and information on the net and some other computational skills. Nowadays, digital literacy is becoming a key requirement for employability. Just like scientific literacy, there are no concrete instruments to determine our digital literacy level or even crucial matters like access to ICT.

**ICT and Public Understanding of Science and Technology**

In last two decades or so, science centres and science museums around the world have adopted a new means of communicating science by utilizing the various possibilities offered by ICT. Initially, ICT entered science centres through stand-alone kiosks that would require individual visitors to interact with. Later-on, ICT was integrated in physically “large exhibits”. Today, high-tech exhibits make use of virtual and augmented reality to give the visitor a new quality of experiential learning. There is also a wide range of multimedia applications being deployed in science centres and museums. It is now obvious that new museological trends favour more and more human-computer interaction given the enormous benefits of integrating ICT in exhibitions. A simple parenthesis on ICT is that it is essentially sending and receiving information through the electronic means which encompasses a wide range of
technologies to include radio, audiovisual media and TV as well as mobile phones and computers. Nowadays, even older technologies are still helpful in many parts of the world. In fact, informal ICT-based learning is already anchored in our society with many countries conducting community radio programmes. By the way, the radio and the television are considered as the most popular ICT devices. With the advent of the personal computer and now the internet as the greatest of all the developments in the ICT field, there is an impetus for ICT-based learning whether formal, informal or non-formal.

The issue of the effectiveness and impact of ICT in public understanding of science is important. In promoting and popularizing S&T, ICT is offering a whole range of potential means and ways. Web-based technologies, social networks, computer graphics, 3-D animations, virtual and augmented reality and other latest development in the ICT field are redefining the way scientific information can be presented and shared to the public. From the museological perspective, there is “no limit” to the amount and variety of information that can be conveyed. Any scientific concept can be demystified using appropriate computer graphics/animations. With ICT at the backbone of exhibit design and development, space management and visitors’ choice of information (audio, video, graphics etc.) become more flexible. There is more room for interactivity, which lies at the core of science centres and museums. From the social point of view, ICT is a driver for social inclusion. By using ICT for the promotion of science and technology, the barriers to sharing scientific information are eliminated.

Although there is significant literature on ICT in formal and informal science education, different countries and different people may behave differently to the integration of ICT to the public understanding of science and technology. Mauritius is a small island developing state which has an often called ‘rainbow nation’ whereby people with different cultural and religious backgrounds live peacefully. The human-computer interaction in this island can be a very different and unique field of study, especially in environments like science centres. The RGSC being the only science centre, and a very young centre, is keen to explore this field. There is practically no research conducted in Mauritius to explore the behavior and attitudes of Mauritians towards the adoption of ICT to enable their understanding of scientific concepts. This study is a first step in this area and gives sense to the need to gather evidence on the expected positive impact of ICT in public understanding of science and technology in Mauritius.

**Aims and Objectives**

The aim of this case study is to gather evidence on the positive impact of ICTs on the public understanding of science and technology in Mauritius. The main objectives are to:

- Determine the effectiveness of ICT-based understanding of scientific concepts among students;
- Obtain an insight of the perceived usefulness and ease of use of ICT to understand scientific concepts;
- Establish whether there is a preference for ICT-based interactions in our science centre.
Methodology

The case study as research methodology was favored due to the social nature of the investigation. It was found to be more appropriate as the research explores human behavior and real-life situations. The approach adopted in this study is quantitative rather than qualitative. Data has been collected through questionnaires coupled designed on Google Forms. A quantitative approach was found to be more appropriate given the time, resources and opportunity restrictions. Moreover, quantitative approaches may be more appropriate in cases where tendency and trends are to be examined.

Sample

Data was collected during the exhibition of the Science Quest 2017, a national science project-based competition, whereby students from various secondary schools all over island, at various levels, came to visit the projects displayed by the participants of the Science Quest 2017. 50 girls and 50 boys, of age 12-14, were chosen from 25 different secondary schools.

Data Collection

In order to meet the objectives of this research, three exercises were carried at the RGSC to collect necessary data. The exercises were organized and planned to allow for free and independent responses from the students. Personal attributes like gender, age, location and IT skills/knowledge have not been considered during the exercises. There was no pressure but it was ensured that all the students submitted their responses before leaving the centre on that day. But beforehand, Students were required to visit and interact with the “Chemical Weapon Convention” corner and the “Science of Sports” exhibitions before answering any questionnaire given to them. A glimpse of the chosen exhibitions is hereby given.

The “Chemical Weapon Convention” corner is the latest exhibit developed by the centre which explore the issues surrounding chemical weapons and looks at the impacts of the use of chemical weapons. It is part of the “Mauritius: Land and Environment” gallery. Its main objective is to create an awareness and inform the public about the causes and consequences of chemicals as well as its potential impacts on their life. A considerable amount of information about the subject matter is presented in the form of panels, videos on displays, quiz/games on tablets and electronic matching game. Figure 1 below illustrates the “Chemical Weapon Convention” corner. The “Science of Sports” exhibition is a highly interactive and educational temporary exhibition developed and set-up by the RGSC. With various hands-on and body-on experiences, visitors are engaged in a variety of sports challenges. From our ancient traditional games such as "La Marelle", "Sapsiwaye" and marbles, to modern and popular games such as golf, bowling, this exhibition is a platform to explore how science and technology is intrinsically linked with sports and games. Participants of the games have the opportunity to challenge your body and mind as you explore how incredible feats in sports are just science and technology at work. There is a well-balanced blend of ICT based, panel-based and body-on exhibits. The ICT-based exhibits are displays showing videos and the Kinect/Xbox 360 video game. Figure 2 below illustrates the “Science of Sports” exhibition.
Exercise 1: A treasure-hunt to determine if ICT based interaction is more effective in retention of scientific knowledge compared to panel-based or other forms of interaction.

Four questions were set on Chemical Weapons whose answers were found in the ICT components (Tablets, videos, displays etc.) of the exhibit and four questions were set on Science of Sports whose answers were found on panels. The performance of the students was evaluated based on the number of correct answers received.

Exercise 2: An Insight of Perceived Usefulness (PU) and Perceived Ease of Use (PEU) of ICT for understanding scientific concepts.

After the completion of exercise 1, it was necessary to establish among our target, the extent to which ICT is considered or accepted as a supportive tool to enhance their understanding of scientific concepts. For this purpose, a survey was carried based on the first Technology Acceptance Model (TAM). The constructs for evaluation are perceived usefulness and perceived ease of use. A Likert Scale was applied for the set of items on each construct. The Likert Scale was designed to obtain an insight of how subjects respond to statements on a four-point scale with the following anchors: (1) Strongly agree, (2) Agree, (3) Neutral, (4) Disagree. The list of items is given in the section 6: Results and Analysis.

Exercise 3: Determination of whether students have a preference for ICT based exhibits.

Since both exhibitions present scientific information through various means, for example, computer games in tablets, movies/presentations in displays, X-box games; electro-mechanical devices; panels etc., a survey was carried to determine the probability that students will interact with ICT features of the exhibitions. Students were surveyed on their preferences from a list of the various attractions of the exhibitions. Three items were surveyed. Details of the items surveyed and the results obtained is presented in section 6.3.
Results and Discussion

Outcome of Exercise 1

Table 1 below shows the percentage correct answers for Exercise 1. It is clearly observed that students had a better response to questions whose answers are found from the ICT features. The overall percentage correct answers were found to be 77 % for ICT-based whereas 72 % for panel-based. Figure 3 is a bar chart that compares the performances. This result can be considered as an evidence to prove that ICT can have a better impact on the understanding of Science.

Table 1: Percentage correct answers for Exercise 1

<table>
<thead>
<tr>
<th>Percentage (%)</th>
<th>Boys</th>
<th>Girls</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICT</td>
<td>Panel</td>
<td>ICT</td>
</tr>
<tr>
<td>Correct Answers</td>
<td>69</td>
<td>60</td>
<td>85</td>
</tr>
<tr>
<td>All Answers Correct</td>
<td>37</td>
<td>20</td>
<td>37</td>
</tr>
</tbody>
</table>

Figure 3: Performance Comparison
Outcome of Exercise 2

The results for each item in the survey is presented as follows:

Perceived Usefulness

Table 2: Result of Perceived Usefulness

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly Agree (%)</th>
<th>Agree (%)</th>
<th>Do Not Know (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using ICT will improve my understanding of scientific concepts</td>
<td>53</td>
<td>41</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Using ICT saves time to understand scientific concepts</td>
<td>47</td>
<td>30</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>ICT makes it easier to understand scientific concepts</td>
<td>42</td>
<td>40</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>I would find ICT useful to understand scientific concepts</td>
<td>35</td>
<td>48</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Average Percentage</td>
<td>44.25</td>
<td>39.75</td>
<td>10.25</td>
<td>5.75</td>
</tr>
</tbody>
</table>

We note a high degree of belief that ICT will be useful to enhance the understanding of scientific concepts.

Perceived Ease of Use

Table 3: Result of Perceived Ease of Use

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly Agree (%)</th>
<th>Agree (%)</th>
<th>Do Not Know (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning to interact with ICT devices in science exhibitions is easy for me</td>
<td>40</td>
<td>45</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>My interaction with ICT devices on science concepts is clear and understandable</td>
<td>23</td>
<td>63</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>I find it easy to use ICT devices for learning science</td>
<td>38</td>
<td>52</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>I find ICT easy to use</td>
<td>45</td>
<td>44</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>Average Percentage</td>
<td>36.5</td>
<td>51</td>
<td>7.75</td>
<td>4.75</td>
</tr>
</tbody>
</table>

It is noted that there is a high degree of belief that interacting with ICTs is easy, free from mental and physical difficulties.
Outcome of Exercise 3

The results of each item in the survey is presented below:

**Item 1:** “Which part of the Chemical Weapon Corner particularly attracted you?”

Table 4: Result for “Which part of the Chemical Weapon Corner particularly attracted you”

<table>
<thead>
<tr>
<th>Part</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz/Games using Tablets</td>
<td>26</td>
</tr>
<tr>
<td>Video on Chemical Weapons</td>
<td>24</td>
</tr>
<tr>
<td>Electronic Animation</td>
<td>24</td>
</tr>
<tr>
<td>&quot;Elements of Chemical Weapon&quot; Panel</td>
<td>16</td>
</tr>
<tr>
<td>&quot;Then &amp; Now&quot; Panel</td>
<td>10</td>
</tr>
</tbody>
</table>

Classifying into the types of interaction, the result summarizes to the chart in figure 4.

![Figure 4: Overall results for “Chemical Weapon Convention” corner](image)

**Item 2:** “Which of the following exhibits in "Science of Sports" appealed to you?”

Table 5: Result for “Which part of the Chemical Weapon Corner particularly attracted you”

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinetic Sports &amp; Bowling</td>
<td>24</td>
</tr>
<tr>
<td>Football Corner</td>
<td>17</td>
</tr>
<tr>
<td>Basket Ball Corner</td>
<td>24</td>
</tr>
<tr>
<td>Athletics Video Projection</td>
<td>12</td>
</tr>
<tr>
<td>Traditional Sports Panel</td>
<td>16</td>
</tr>
<tr>
<td>Ball Science Panel</td>
<td>6</td>
</tr>
</tbody>
</table>
Grouping into ICT-based, Panel-based and Electro-mechanical based, the results summarizes Figure 5.

![Figure 5: Overall results for “Science of Sports” exhibits](image)

Generally, ICT-based interactions emerge as the ones that appeal the most, as illustrated in figure 6 below:

![Figure 6: General results](image)

**Item 3: “What is the probability that a student will do the following:”**

Table 6: Result for “Which part of the Chemical Weapon Corner particularly attracted you”

<table>
<thead>
<tr>
<th>Interactions</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interact with Tablets</td>
<td>0.47</td>
</tr>
<tr>
<td>Read from Panels</td>
<td>0.12</td>
</tr>
<tr>
<td>Interact with Electromechanical Exhibits</td>
<td>0.15</td>
</tr>
<tr>
<td>Observe Exhibits</td>
<td>0.12</td>
</tr>
<tr>
<td>Watch Videos</td>
<td>0.13</td>
</tr>
</tbody>
</table>
It is observed that there is a high probability that a student will interact with tablets in a science centre environment. This shows that youngsters prefer to interact with popular technologies/gadgets.

**Conclusion and Recommendations**

Our case study research has shown positive results on the potential of ICT-enabled public understanding of science and technology in Mauritius which also initiates a deep reflection on the e-promotion of S&T in Mauritius and other small-island developing states. Nowadays, the miscellaneous forms of information display and interaction offered by ICT is revolutionizing the field of science promotion and popularization. ICT and Public understanding of science and technology is even taking a different dimension as science centres and museums have recourse to virtual and augmented reality to engage its target public in S&T.

The main conclusions are:

- ICT is considered as a strong tool to enhance the public understanding of science and technology in Mauritius. “Learning with, for instance, mobile game technologies can indeed make learning more pleasant and more effective.” Naismith et al (2004).
- Students strongly believe that the use of ICT will enhance their understanding of scientific knowledge. It is also believed that ICT-based interactions are easier and free from mental and physical difficulties. There is clear indication that the intention to accept ICT is high among our students.
- The younger generation of secondary students have a preference for ICT-based interactions in S&T.
- ICT can become a key driver of informal learning of science in Mauritius.

In science centres, we are of the opinion that technology must not take the place of real visits. Technology must be integrated to allow for novel interactive experiences. The integration of ICT in the design and development of exhibits, however, has to have a limit in order not to detriment other forms of experiences. Science centres, with the pervasive and all-encompassing nature of ICT, need to envisage a more inclusive approach to the promotion of S&T. ICT can be used to attract youngsters. For example, youngsters are very much attracted to latest technology gadgets. By employing such gadgets in exhibits, we can enhance the promotion of S&T. By choosing to communicate scientific information in the preferred form of our youngsters, the impact can be higher. As all countries fighting poverty and social exclusion, ICT is a key tool to enable science centres to reduce digital divide and bridge the gap between ICT and the poor.

The challenge, however, is to use and to improve the use of ICT applications for informal learning of science for visitors of different interests and skills in ICT. Whereas the participatory aspect of ICT appeals for youngsters or educated audiences, it is equally important to present ICT based interactions in forms that will appeal to “all”. Also, ICT-based exhibits have a tendency to be one-visitor centered which is detrimental to family visits as they may not appreciate such types of exhibits and this can impact negatively on our quest for engaging general public in S&T.
The limited time over which this research was conducted prevented an in-depth analysis of the results. This forwards us to the recommendation that there is substantial research and studies about the potential employment of ICT in enhancing the public understanding of science and technology in Mauritius. While integrating ICT in exhibit design and development for communicating scientific information, major research considerations needs to be given to the physical aspect of ICT-based exhibits, the human-computer interaction, the mixed and variety of our target audiences as well as the digital skills level.

The deployment of ICT in the enhancing public understanding of science and technology with a view to improving scientific and digital literacy will be a key step towards achieving the United Nations 2030 Sustainable Development Goals. It will also support the Government of Mauritius in its strong intention of transforming Mauritius into a digital island.

Acknowledgement

We are thankful to all the students who have participated in this case study and appreciate the support of the accompanying teachers, rectors/heads of schools/colleges and the Ministry of Education & Human Resources, Tertiary Education and Scientific Research. We would like also to thank the Open University of Mauritius and the University of KwaZulu-Natal for organizing the E-MIG conference and generating the impulse for this case study. We also remember all those who have indirectly contributed in this endeavor.

References


Role Based Access Control using Ontologies

Ms. Smita Chavan1, Dr Sharvari Tamane2
Government Engineering College, Aurangabad, India
MGMs Jawaharlal Nehru Engineering College, Aurangabad, India
rathod.sb@gmail.com; sharvaree73@yahoo.com

Abstract

Data security is very important aspect of cloud computing. The most widely used method to protect data in the cloud is encryption. This type of authorization uses two types of control methods: attribute based access control (ABAC) method and role based access control (RBAC) method. This paper is focused on role based access control method which is implemented using cloud computing. Right of entry allows an ability to manage data access to areas and resources in a given information system. Data may be related to semantic web, context data, identity based data, enterprise data etc. This data may be affected by unauthorized access. For higher security, client personality ought to stay escaped from CSP (Cloud Service Provider). Security of data is maintained by encoding before outsourcing it. By considering the substantial number of data clients or archives in the cloud, it is essential for the pursuit administration to permit multi-keyword inquiry. It gives results according to the matched keyword. In this framework, we have characterized and tackled the testing issue of security along with safeguarding multi-keyword positioned encoded cloud data.

Keywords: Cloud Computing, Encryption, CSP, Keyword Search, Privacy, Role based access control.

Introduction

Cloud Computing is defined as a network of servers remotely placed and hosted on the web to process different types of data, other than a server locally placed or a personal desktop. Cloud computing contains mainly three types of services: Infrastructure as a service (IaaS), Platform as a service (PaaS) and Software as a service (SaaS). IaaS provides access to business for web architecture, like servers, connections and storage space, instead of the business need of managing and purchasing this web infrastructure among them. PaaS provides deployment as well as scalability services for different types of applications using clouds. SaaS is comparatively older than IaaS and PaaS. Cloud applications permit it to remain controlled for software architecture it has used. It decreases the load of users of preserving, sustaining and managing it. It can be operated by running it on number of desktops through various locations. Cloud computing is useful to access applications like utilities over the internet. Most of the time it configures and manipulates the cloud applications. There is no need to install a particular portion of software for manipulating or accessing different cloud applications. Resources related to cloud are obtainable with the network as it gives a platform autonomous access to different types of clients. It also offers on demand services. Cloud computing is very much cost effective as it controls services at higher efficiencies with better utilization. Cloud storage is also one of the very important service of cloud computing. It is generally known as
model of data storage. Cloud storage stores the digital data in the form of logical pools. The physical data storage may require several servers at various locations with physical background. It is usually owned and managed by a hosting company. The cloud storage providers are responsible for making the data available and accessible. Organizations and/or users can ask for fixed/dynamic storage capacity from the cloud providers to store application data, user information and organization data. Cloud storage services may be accessed through a co-located cloud computer service, a web service application programming interface (API) or by applications that utilize the API, such as cloud desktop storage, cloud storage gateway and web-based content management systems.

There are different issues available in the cloud data storage. One of the very important issues is the security. Security challenges in cloud computing fall into three wide categories. Protection of data: to secure data both at rest and in motion. Authentication of user: to limit access of data and keeping track who accesses the data. Data breach and disaster: possibility planning. Other security issues may include trust, privacy, ownership, performance and data backup.

Commonly used method to secure data in the cloud is called as encryption. Encryption utilizes two types of control methods: attribute based access control (ABAC) method and role based access control (RBAC) method. This paper focusses on RBAC method. RBAC controls right of entry to the computer or resources related to network depending upon the assigned roles strategies for particular users within an organization. Access is the capability of single user to execute a task (view/create/modify) for a file. Roles assigned to users can be created, modified, removed easily depending upon the organizations need without changing the users privileges.

**Related Work**

Reference paper [2] guaranteed about the security as well as confidentiality for sharing of data in cloud background. It has used well-organized and flexible control scheme for accessing data, which was supported for encryption of attribute-based as well as commission standards. It has also provided information about users membership (static or dynamic). Logic expressions were defined in an efficient manner. Thus system is more efficient for securing data on cloud. It has stated in the paper that the system can be extended by implementing it with different algorithms for efficiency. Reference paper [3] proposed proxy re-encryption scheme for data security, by semi trusted proxy that converts a cipher text of sender into a cipher text of receiver without referring to the original plaintext. The paper represented few re-encryption methods which included various schemes for security along with the facility of adding access control to read only file system. The paper has also given solutions for practical problems of securing proxy re-encryption designs for different applications. Paper [4] proposed efficient identity-based encryption (IBE) design method. The difficulty of learning with error problems is called as LWE. LWE is secure against adaptive chosen identity and plaintext attack. For encoding purpose system has used matrix form methods.

Paper [6] had identified the problem of managing access rights to use resources in cloud computing. It is very difficult for users to access the data if all organizations data is combined into virtual organizations and share various resources located at the cloud providers. The paper has proposed an approach for different types of requests which should be automatically
deployed on the cloud service providers. Even if organizations data is combined, resource management should be done properly. Paper [8] proposed the applicability of their structure for sharing of broadcast encryption and audit log information. The system has developed hierarchical identity-based encryption method. Reference paper [9] described a survey of attribute based encryption usage on cloud. The paper has also made analysis of widely different types of attribute based encryption (ABE). Different numbers of methods for access control are accessible on cloud platforms. ABE method is compared with other methods for deploying different types of applications on cloud platform.

Methods

Problem Definition

By using RBAC, roles are cleared along with assigned names. Roles verify the permissions set which are assigned to users. RBAC system is very simple to understand in which user has authorized access to assigned permissions. It is also easy to specify which types of permissions are granted to users. Roles are analyzed before using RBAC method. RBAC can also be used to handle roles dynamically over the time. System can provide role specifications with a data-centric access control solution. Security is considered for defending user data on cloud service provider. Authorization rules are protected and data is encrypted by using cryptography to maintain it against the service provider. System can provide hierarchy of resources and roles. By using hierarchies system can benefit the logic formation provided by web technologies (semantic). These web technologies allow advanced management of rule like conflict detection. In the proposed system data is uploaded to a cloud by using an encryption method, AES algorithm. In reality, an extensive number of requests for data are made by clients and due to vast amount of data records present in the cloud, it is difficult to get the correct result. Our objectives are:

- To develop a system that stores the data on the cloud in an encrypted form and provides highest security to it
- To set up an encryption based method for protecting the data on the cloud and provide the information to access it
- To retrieve the encrypted data stored on the cloud through an authorized user and decrypt it before its use.

Proposed System

The system proposes a successful framework for the security of uploaded data in a cloud by using encryption standards. Any authorised client can do a hunt on an encrypted data with numerous catchphrases; these catchphrases are used to search data in an uploaded file without uncovering the actual contents of a file. The system then lists all the files matching the catchphrase in a cloud. Required files can be downloaded by selecting one of the file from the list generated in above steps.

System can input different types of files according to the data records: Semantic web, context data, identity based data, enterprise data etc.

Following are the basic building blocks of the process. These are related to the data and keywords as given below:
In general overall process is to encrypt data using encryption key while uploading and decrypt it while downloading using the same key.

![Encryption/Decryption process]

Process of transforming cipher text messages back to plaintext is called decryption. It is the reverse process of encryption.

**System Architecture**

![Architecture for deployment in a CSP][11]

Figure 2 shows basic architecture for deployment in the cloud service provider (CSP). Three core elements used in the structure are given as follows:

A. **Cloud storage**: It brings together private information store. Cloud server essentially holds manager credentials, encrypted information and keywords available in the file. Cloud storage server stores information about data and users (roles).

B. **Data owner**: Information manager categorizes an archive uploads. It also makes new clients. Data Owner has full access to all resources (websites, virtual machines, and subnets) including the right to delegate access to others.

C. **Data user**: The clients are end users who can hunt that information stored on the cloud server.

The data user and the data owner have authority to access control as well as search control. Data user makes request to search on the cloud server and response from the specified server. It indicates rank result according to the request for particular data. Encrypted data index contains objects of data and rule set for authorization which is accessed by data owner from the cloud server. Objects of data are encrypted before uploading it to the CSP or prevent access to CSP. This encryption is processed by data users by using the function encrypt(). Encryption of data objects uses a symmetric encryption algorithm called AES algorithm. In this algorithm random symmetric keys are generated. Data owners defines authorization rule for mapping on authorization model.
Results

Implementation Steps

Databases like data owner and storage cloud are the basic databases used in the project. This consists of tables like client domains and owners. The system is configured to run on local host (single system). It can be implemented further to run on specific IP. System runs four different modules: Client, data owner, storage cloud and utilities. The system has implemented AES algorithm through the helper classes available in the java. This algorithm is at least six times faster than the triple DES algorithm. It uses block size as maximum of 256-bits key. AES provides full specifications and design goals. Thus AES encryption provided excellent security. Alternative method to this is to use Java 8 new classes which are available in the package named java.util for encoding and decoding purpose.

*Output for bounding as per users IP:*
System uses keyword match for ranking scheme. Input is users query and output is keyword extraction. Ranking criteria is specified on the basis of implicit and explicit properties such as content relevancy, user interest and response time. Figure.3 shows keyword rank graph as per the given keywords.
Figure 3: As the keywords increases/match the rank of the matched file increases

Conclusion

Our research indicates that the security is the major issue that is needed to be countered. Efforts are being made to develop many efficient systems that can provide security at the user level. Our method states that encryption is one such method that can provide peace of mind to user and if the user have control over encryption and decryptions of data that will boost consumer’s confidence and attract more people to cloud platform. Proposed system can be extended to configure for multiple organizations of data from multiple locations using role based access control method.

References


Abstract

The Lean and Agile Systems Development Teaching Approach fuses the principles and practices of Lean Startup and the Agile Software development movement to manage and teach the practise of software development in an educational setting. The Approach means to expose participants to the system development life cycle while simultaneously promoting a process-based approach to developing software and educational artefacts. The proposed Approach is meant to be useful for “messy” real world problems that students and educators encounter within and outside of the academic domain. It emerged from the experience of having to initiate a diverse group of students with different social and educational backgrounds into systems development at university level. The approach espouses an Agile mindset in problem solving. The Approach encourages self-reliance and the use of free (or low cost) open source and/or cloud-based project planning, scheduling, analysis and design platforms and tools, thus lowering the barriers to entry for software development. The Approach encourages participants to appreciate the utility of crowdsourcing platforms to raise funding to pursue entrepreneurial activities. The Approach is a method which has been implemented and tested on university courses for introducing the software development life cycle. The processes, deliverables and workflow in the Approach are derived mainly from the disciplines of Agile (SCRUM and eXtreme programming), Lean startup, and Peircean semiotics. The Approach recognises the value of encouraging entrepreneurialism and incorporates basic business planning and fund raising into the proposed methodology. The Approach fuses and adapts the various principles of the aforementioned disciplines, encourages an Agile mindset, and espouses a Lean and Agile Systems Development Approach to the “messy” discipline of systems development in educational environments.

Keywords: Agile, Lean startup, Peircean semiotics, Systems development, entrepreneurship, teaching, Agile mindset

Introduction

“The situation the world is in is a mess. This hardly requires documentation; it's obvious” (Ackoff, 1971).

The Lean and Agile Systems Development Teaching Approach (forthwith: the Approach) is an attempt to manage a “messy” real world problem, as Ackoff (1971), the “father” of modern systems theory well appreciated; real world problems are multi-dimensional and require a holistic approach.

The Approach represents a reformation of personal educational practice with the ultimate objective of a transformation towards empowerment, entrepreneurialism and innovation as a central educational goal. This Approach does not claim to do things “right” even though it does intend to, rather it seeks to guide the participants to explore their own creative potential, by attempting to solve “messy” problems in the educational and Information Systems domain respectively, in a manner which is hopefully transformative for the participants’ engagement.
with the discipline. The academic domain is “Messy” because it is attempting to satisfy so many different goals at the same time; especially when teaching systems development using a life cycle approach, in short courses at university level, to a diverse body of students, with different educational backgrounds and first languages – it’s “messy”.

Not only must students be introduced to the tools, methods and practices, they must also produce an artefact whilst meeting and satisfying standard educational goals such as acquiring knowledge and meeting assessment criteria. While educators often need to deliver excellence with scarce resources, one really needs to foster an Agile mindset to function in such a “messy” environment.

**Research objectives**

The overall objective of this research is to present an approach to teaching systems development projects using (mainly) a novel fusion of Agile and Lean Startup principles and practices. The Approach seeks to promote the cultivation of an Agile mindset and a process-driven approach to systems development.

The educational objectives include coping with large student numbers, decreasing opportunities for plagiarism, encouraging creativity and engagement with course material, and conducting fair and appropriate assessment. Finally, it is demonstrated that the Approach is reasonably scalable and has the potential to decrease the assessment and workload on lecturers.

**Research context**

The Approach is not put forward or meant to be a fully complete or static methodology, rather it evolved, and will continue to do so, from my own particular experience and the various challenges I faced teaching systems development at university undergraduate and postgraduate level.

The Approach expects each practitioner to utilise the principles, practices and processes to the depth necessary to accomplish the (potentially evolving) goal of the systems development project and educational context in which it is iteratively employed. It is a fusion of a number of different traditional methodologies and practices inspired by the principles espoused by Beck et al. (2001) in the “Manifesto for Agile Software Development”, and some of the techniques and practices of Lean Startup (Reis, 2011). It is motivated by the particular needs of the Information Systems (IS) discipline as a whole with the educational goals centred around the creation of an artefact, the Minimal Viable Product (MVP) as conceptually understood in Lean Startup (Reis, 2011) terms. What particular form the artefact or product takes is largely immaterial to this method, as the principles and practices can be used to organise differing teams of participants to accomplish a variety of work.

An Agile mindset is encouraged, meaning, that each iteration will be unique in some manner, and the agile practitioner will need to respond and adjust to circumstances as they evolve. The above may well sound anathema to an academic setting where methodologies and processes are employed in strict and formal manners, however, in this paper we regard an Agile mindset as just important for driving engagement, creativity and flexibility in the academic project.
Limitations

This paper is positional in that it mainly outlines the Approach, it has not significantly invested in testing all of the various elements, as it has been written largely from an experiential perspective. The ability to measure the effectiveness of the methodology, MVP and experience as required by Lean Startup will require future research to support and substantiate the Approach.

Elements of the Approach

The Approach variously adopts and fuses the methodologies and techniques associated with Peircean semiotics, Lean Startup, Scrum, and eXtreme Programming (XP) for problem solving and for managing the system development process.

Agile

The Approach values similar ideals to those so eloquently listed in the “Manifesto for Agile Software Development” by Beck et al.(2001). In particular, it values “Individuals and interactions over process and tools ... (and) ... responding to change over following a plan.” The approach does not dismiss planning or tools and processes, it embraces them, but recognises that an Agile mindset is most important when confronting real world “messes” in the sense that Ackoff (1971) understood them.

Definition

Agility by nature is an adaption to change; an Approach to dealing with change, and ultimately a mindset (Denning, 2016). According to Denning (2016): “If you have the right mindset, it hardly mattered what tools and processes you were using, the Agile mindset made things come out right. Conversely, if you didn’t have an Agile mindset, it didn’t matter if you were implementing every tool and process and system exactly according to the book, no benefits flowed.”

Agility is more than just an effective response to change, it is a philosophy (Pressman, 2003) and a mindset in which you should value people and interactions over processes and tools (Beck et al., 2002). Agile processes need to accept change, rather than stress predictability (Schwaber et al., 2002).

Lean Startup

According to Reis (2011): “Startup success can be engineered by following the process, which means it can be learned, which means it can be taught.” Reis (2011) identifies an iterative process of building, measuring and learning as core to Lean Startup. Conceptually, ideas must be developed by building something tangible (through coding in IS); the effectiveness of the product (or associated artefact) must be measured in some manner, and the data analysed to learn, so that the idea may be innovated through subsequent product iteration (cycles).

Lean Startup measures progress through validated learning; this involves demonstrable progress in building the thing that customers want. In Reis’ conception, customers will “pay” for the right thing (Reis, 2011). While validated learning may for start-ups be monetary, we have adopted the sentiment of validated learning academically. Economically products may be measured in monetary terms, or per discipline, in any other measure we regard as validating our pursuit e.g. research publications, community service awards or assessment
results. Lean Startup requires that measurement in general is *actionable, accessible* and *auditable* (AAA) and thus of some quantifiable merit. *Validated learning* should demonstrate that your *product* is (self) sustainable at some level, and thus your AAA metric should help you determine this in some manner e.g. downloads, citations, revenue (Reis, 2011).

**Scrum**

Scrum is a means of managing a work process (workflow) to develop a *product*. The *product backlog* consisting of *user stories* is divided amongst various *sprints* which run over particular time periods. (Satzinger et al., 2014). Sprints can be of any length in theory, but will be punctuated by short meetings to discuss work to be tackled between sessions. (Satzinger et al., 2014). Scrum planning meetings (Schwaber et al., 2002) are used to plan the way forward between sprint cycles; the scrum and sprint cycles should deplete the product backlog (collection of all outstanding user stories). The combination of these iterations should incrementally develop the product. Sprints are accomplished by team members who take on various roles (Satzinger et al., 2014). There are a number of designated roles with associated responsibilities, including the *product owner* who controls the product backlog which is built through iterative activities (Schwaber et al., 2002) Teams may be multi-disciplinary, and members may carry out one or more roles associated with creating the necessary artefacts e.g. requirements gathering, design, prototyping. The team should be able to redeploy (and reconstitute) as necessary. Team dynamics are facilitated by the *scrum master* who removes impediments to progress, while the team sets the schedule and assigns tasks (Satzinger et al., 2014). None of the team roles are static, meaning that the team decides who is best to carry out a particular role or activity. It encourages a flat hierarchy, with the primary recognition that all members are *equally* important, and that the primary objective is to solve the problems facing the team effectively and efficiently. As Pressman (2003) recognised, process models should provide “a *realistic* mechanism for encouraging the discipline, or they must be characterised in a manner that show *tolerance* for the people who do the software engineering work.” As a researcher and educator, we propose both - realism and tolerance. This does not mean that the project should descend into organised chaos, members can and do settle into roles, but an *Agile mindset* should be maintained.

Scrum requires 4-5 team members for the process to be used effectively – which we implement at postgraduate level - or an individual may find themselves with too many roles and responsibilities for practical progress to be made (Satzinger et al., 2014).

The product backlog is iterated through sprints (Satzinger et al., 2014) which result in the workload being burnt-down (or up) depending on which measurement you require Burndown charts plot work left to do (and completed) versus time. Burnup charts track the project’s progress and shows total work completed versus project scope - total work contained in the product backlog. Scrum Planning Meetings decide on the work to be completed in a sprint or *timebox* (Satzinger et al., 2014), the daily sprint depletes the backlog, and is punctuated with short meaningful daily planning (stand-up) meetings. Questions and reflections are posed in daily scrum meetings regarding what went well, what went badly, how can things be improved, are there any impediments to my work (Satzinger et al., 2014)? It is the team leader’s role to facilitate these meetings, to remove impediments to the team’s progress where possible, and to bubble larger issues outside of their control up to the product owner and thus stakeholders (Satzinger et al., 2014).
eXtreme Programming (XP)

XP is used when teams are generally much smaller – as in the undergraduate course. Traditionally it is associated with the pair-programming practise, an intensive form of writing computer code, where programmers work collaboratively to produce working code. They take turns working a piece of code, one doing the actual coding and one observing and advising (reviewing) the progress. Ultimately it is the simple recognition that “two heads are better than one”, and that co-operation facilitates progress. XP has defined activities that are carried out iteratively, spiralling in from the periphery of a circle to complete a cycle of work, before breaking out from the centre and if necessary, iterating the process again (Satzinger et al., 2014). User stories are a means of capturing requirements in XP. User stories are used to create a system metaphor (Khaled et al., 2004) which is a means of envisioning, inspiring and communicating core ideas about the artefact to be created.

Peircean semiotics

The idea of metaphoric communication is especially intriguing to my mind. After all, information systems are abstractions of, for, around and about ‘real world’ entities and everything on the screen is metaphoric i.e. virtual.

System metaphors are an XP concept which this Approach has adopted and utilised as way of exploring and defining the problem and idea. In essence, this Approach uses the concept of a system metaphor to explore a problem and define a means of representing it or communicating it visually and textually. In this regard, I adopted the ideas of Khaled et al., (2004): “The system metaphor is a means of communicating about the project in terms that both developers and customers will understand, and which does not require pre-existing familiarity with the problem domain The system metaphor guides the mental models that project members have of the system, and shapes a logical architecture for the system. Experience with XP shows that the system metaphor practice is the most commonly dropped practice, due to a lack of understanding of how to use it, and the difficulty of finding an appropriate metaphor.”

Khaled et al. (2004), introduce the notion of using Peircean semiotics as a means to represent system metaphors. In particular, they propose Peirce’s’ triadic model of the sign as a basic formal structural approach to representing system metaphors. The referent is the concept (idea) one wishes to communicate, the representamen is the (visual) embodiment of the sign, and the interpretant is the (intended) concept / thought / idea you wish the sign to convey or trigger in a perceiver’s mind (Khaled et al., 2004). One can chain these triadic signs together using metaphoric entailment to develop more sophisticated and nuanced signs, compounded ideas and concepts.

A system metaphor can in theory guide development at different levels of the stack whether it be architectural, programmatic or testing (Khaled et al., 2004). However, in my simple adoption of the approach, the participants are encouraged to create simple product metaphors, as a means of expressing and communicating their ideas. These metaphors are used to develop a language and basic symbology to communicate and express the product idea at various conceptual levels in for example, product marketing literature, the user interface or in user documentation. It becomes a means of expressing a brand or communicating an idea with its accompanying symbols and language ion a holistic. A good
system metaphor - in my opinion - should be a step towards a meme, it could (in theory) go viral because it represents, communicates and has effective utility at the same time.

Methods

Figure 1: Lean and Agile Systems Development Approach (de la Rey, 2015-2017)

The Approach (shown in Figure 1) incorporates elements from the numerous sources mentioned above. It is not meant to be inviolable, rather it is a collection of elements, each of which contributes to producing a product. The depth to which one expects a particular artefact to be developed depends on the context and needs of the course, project, participants, time-frame etc. available; the Approach espouses an Agile mindset and it is as lean as the ultimate sponsor (educator) requires.

Participants

The participants are shown in the centre with their designated project responsibilities shown in blue on the left, on the right are the entrepreneurial artefacts.

Starting at the top-centre of Figure 1 are the project stakeholders and project sponsors, those who are ultimately invested in the outcome of the process i.e. the product. These may differ depending on the project. In our test cases, there are differences between iteration at undergraduate and postgraduate levels. Stakeholders in general, include the facilitator, educator, and the department and university, advisory board (industry partners) and external clients. Practically, it also includes the students as they have a direct stake in passing the module. In this case, the students were ultimately playing multiple roles in the process as part of the educational exercise - the Approach is comfortable with a single participant playing multiple roles, and the rotation of (almost) any role as deemed appropriate by the participants.
The project sponsor is the visionary (and the financier or conduit) of the project. It is they who provide the project direction in terms of what the acceptable final MVP is. In the case of the postgraduate projects, participants from industry provided the project ideas, and the author acted as facilitator and project co-ordinator. However, the author also proposed a project, and thus was also a project sponsor.

At undergraduate level, the students are expected to envision their own product. They were in theory, working to innovate their own idea via the project into a MVP which could then be put forward to a crowdsourcing fundraising platform to raise finance in the ‘real’ world. Undergraduate teams consisted of 1, 2 or exceptionally 3 members, while postgraduate teams consisted of 5-6 members. Deliverables at postgraduate level are usually more in-depth, with students expected to produce a working MVP, while at undergraduate level, the students mainly produced basic screen designs and project management / planning documents as prototype MVP components.

In larger teams, the product owner is that member of the team that captures and communicates the requirements of the stakeholders to the team as user stories. The product owner manages the relationship with the stakeholders. The team leader is tasked with team facilitation and managing the workload of the team, interceding between the team and product owner. The team is tasked with carrying out development work as determined negotiated by the team lead. End users provide feedback to the team leader who communicates with the team. The team are responsible for the actual building of the MVP. Members will naturally gravitate to a particular role e.g. design or implementation. In the academic setting one may well require students to rotate roles to gain experience of the various activities and deliverables.

**Deliverables and process**

The Approach espouses a particular problem solving approach with associated entrepreneurial artefacts, shown on the right and numbered 1-7 respectively in Figure 1.

*Part 1* consists of a problem statement or description in which the problem domain is explored and explained in as much detail as necessary. The problem statement can be complemented with a domain study for providing a context. The domain study would encompass a review of similar projects, problems and solutions in the public domain. It is from the detailed problem statement that the problem attributes are derived. Problem attributes are in effect sub-problems. The problem attributes will be listed against the proposed metaphors in the metaphor matrix, to determine which metaphors are most appropriate, each is given a nominal score which acts as a ranking showing the relevance to solving the problem.

In addition to the problem statement, the participants should create a hypothetical value proposition (HVP). A HVP is a concise statement of what benefit or utility the MVP will be to the user or customer. As such it provides a high level acceptance test to measure the final product efficacy.

*Part 2 & 3* consists of deriving the system metaphor using the metaphor matrix, 4 key objects and Peircean triad exercises respectively. Candidate metaphors are ranked and scored using a metaphor matrix approach adopted from XP practices as explained by Wake et al.(2012).
Metaphors are a useful means of creating a shared vision for the project, they also can be used to derive a vocabulary and naming convention for the system, lead to new insights (generativity), and help to understand the Architecture of the system (Wake et al., 2012). Finding candidate metaphors is a creative process in itself, and Wake et al. (2012) suggests a brainstorming approach using cards to help with the process.

Once inappropriate metaphors are eliminated, candidate metaphors are chosen to be further developed using the 4 key objects exercise. The exercise unpacks each metaphor to find the key objects implied by the metaphor which should provide insight into the way your system interacts (Wake et al., 2012). Ultimately, candidate metaphors (or the insights obtained) are developed into the system metaphor using the Peircean triadic metaphor chaining process. Alternatively, we have found that applying the triadic process to individual key objects and then chaining these together can also result in a compound system metaphor. Thus, in summary, Peircean triads are employed in this Approach to create a system metaphor that communicates and represents the central idea of the team which will be embodied in the MVP. The resultant images, symbols and vocabulary developed should also be used to communicate about the MVP in any subsequent marketing or crowdsourcing activities.

Part 4 consists of creating the product backlog which consists of user stories and acceptance criteria with associated tests, organising these into sprints and starting the translation of these into the MVP via the chosen design and implementation approach. The students apply project management skills to estimate the time, points and costs of implementing stories using an agile backlogging tool (as simple as a blackboard if necessary).

Part 5 consists of constructing a basic business plan, which in our context was rudimentary, but again made use of a simple cloud-based tool to put business planning elements together. Costs derived from the backlog and user stories estimations are associated with necessary resources requirements such as people, resources and revenue streams in a high level manner as an elevator pitch – the depth of which may be tailored to the course requirements.

Part 6 then combines the above to create a crowdsourcing campaign (using an online tool) as an example of how funds may be raised without the necessity to take loans from a bank. It expects the students to present or market the product to an online target audience.

The text in blue on the diagram (in the area labelled 1) details the various activities and deliverables associated with different roles. The undergraduate students without a deep team structure, are still expected to produce most of the deliverables, though not to the same depth as at postgraduate level. The relationship of the deliverables to one another is shown in the area marked 2 in Figure 1. Most of these deliverables can be worked on concurrently, however, there are dependencies, and the suggested flow is show in the diagram from left to right.

Assessment

The undergraduate project was iterative and cumulative, it was assessed over 4 weeks of the course, in weeks 2, 3 and 4 respectively. Students were assessed in practical by their designated tutors and in the theory exams using graded multiple choice questions (MCQs).
Graded MCQs were used. These means that each question could have *more than one partially correct* but *only one fully correct* answer. Marks could thus be accrued in small increments, eliminating an *all or nothing marking strategy*. Importantly, marks were also subtracted using negative marking of 0.25 per wrong answer to discourage guessing.

Tutors were expected to give students a mark guided by an assessment schedule for the relevant artefacts produced. Additionally, formative feedback was given in weeks 2 and 3 respectively, so that the students could revisit and improve their work. In week 4 the students had to present and demonstrate their entire project at their designated practical session. This approach means that students have time to reflect on and improve their work and tutors are given the opportunity to grow their own interaction and assessment skills. The lecturer should be available at assessment sessions to provide guidance and moderation as and when necessary. Tutors should also be briefed beforehand as to assessment guidelines and practices.

At postgraduate level, the students were subjected to both internal and external examination processes, the external moderator was given the final say on each team’s result. All students in a team received the same result, a buddy rating system was not applied. Postgraduate students received good results from the external examiner, but no course evaluation was carried out, and hence the results will not be further examined here.

**Results**

*Course evaluation context*

The course itself was evaluated using a survey. The questions may seem rather general as they spoke to whether or not students found the overall aspects of the course which affected them to be effective. However, the researcher was attempting to deal with a number of issues related to course delivery and resource constraints, such as the ability to cope with high numbers of students with limited resources. The researcher developed the proposed approach to cope with the need to deliver and manage a systems development course within institutional and personal constraints. This Approach emerged through trial and error and experience and maintaining an *Agile mindset*.

There are no undergraduate course evaluation results for 2016 as the university was disrupted by student protests. Interestingly enough, the postgraduate projects were concluded successfully, even though they occurred over the exact same time as the disruptions! Speaking perhaps to the veracity of the Approach which in our opinion allowed participants to adapt to the challenging circumstances successfully.

Table 1 shows the results of the undergraduate course evaluation. In 2015 there were a total of 71 respondents (21%) from a pool of 325 registered students. In 2017 there were a total of 60 respondents (21%) from a pool of 284 students.
<table>
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</thead>
<tbody>
<tr>
<td>Q1 I enjoyed the opportunity to work in pairs.</td>
<td>28</td>
<td>40</td>
<td>24</td>
<td>23</td>
<td>17</td>
<td>14</td>
<td>12</td>
<td>17</td>
<td>3</td>
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<tr>
<td>Q2 I enjoyed the ability to choose our own unique project.</td>
<td>45</td>
<td>57</td>
<td>34</td>
<td>33</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>10</td>
<td>0</td>
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<td>Q3 I enjoyed the fact that the project evolved over time and grew cumulatively to the presentation stage.</td>
<td>41</td>
<td>52</td>
<td>32</td>
<td>37</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>8</td>
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<td>Q4 I feel I learnt a great deal from the project and would like more practical work like this.</td>
<td>41</td>
<td>38</td>
<td>23</td>
<td>28</td>
<td>17</td>
<td>12</td>
<td>6</td>
<td>18</td>
<td>14</td>
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<tr>
<td>Q5 I feel that the project was fairly assessed by the tutors.</td>
<td>38</td>
<td>45</td>
<td>28</td>
<td>43</td>
<td>14</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>13</td>
<td>2</td>
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<td>Q6 I feel the project should count more towards our final IS201 mark.</td>
<td>42</td>
<td>63</td>
<td>21</td>
<td>18</td>
<td>13</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Questions</td>
<td>Agree Whole Heartedly</td>
<td>Agree</td>
<td>Neither Agree or Disagree</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
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<td>Q7 I think graded MCQs (more than one partially correct answer) is a fair mechanism.</td>
<td>39</td>
<td>20</td>
<td>32</td>
<td>15</td>
<td>7</td>
<td></td>
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**Interpretation of results**

Q1: Since the course has a large number of respondents it was necessary to try to decrease the number of physical projects that needed to be assessed. Putting the students into pairs is an XP practise, thus I was interested to see whether respondents were comfortable with pair based worked. Importantly, students could choose to work either in pairs or alone. While 52% in 2015 and 63% in 2017 of respondents respectively enjoyed working in pairs, 21% in 2015 and 15% in 2017 cumulatively disagreed or strongly disagreed. The question does not allow us to distinguish between those that had a bad experience working in pairs or those that chose to work alone. The Approach demonstrates agility here as it allows students to work cooperatively or singularly.

Q2: The ability to choose their own project was well received - 89% in 2017 and 79% in 2015 either agreed whole heartedly or agreed. This is important because previously the course struggled with plagiarism as students were all expected to complete the same project – a paint by numbers approach. Allowing students to choose their own projects enabled them to pursue an idea they were interested in, while also ensuring that no two projects would be the same. The Approach is not dependant on the project idea, rather it focuses on the processes and learning objectives, thus freeing the facilitator from having to produce model solutions which need to be updated and changed each year to discourage plagiarism.

Q3: This question thus related to the student’s experience of that portfolio assessment technique. The students created a portfolio for the project, stand were given formative and summative feedback for the project each week. At the final assessment all aspects of the portfolio were re-examined. If they had improved a previous deliverable, they had an opportunity to better their mark for that component of the portfolio. If not, they received the same mark as before for that component. The two marks were then averaged to give them the final mark for that component of the portfolio. The final portfolio assessment also had aspects which were not previously assessed, and these received a single mark per deliverable. Each deliverable had an overall weighting, and in combination the portfolio mark is derived.
These allows for agility and adaptability in weighting. In 2015, 73% and in 2017, 81% of respondents either agreed whole-heartedly or agreed.

Q4: This question is a combination of all the previous factors together, and an attempt to gauge sentiment for the overall approach. Normally students are given once-off practical assignments where they don’t have the opportunity to reflect and improve their own ideas, or to work in pairs. Also, plagiarism is an issue as all students are given the same practical to complete. This question wished to see whether the respondents preferred this type of work as a learning experience. In 2015, 64% and in 2017, 66% of respondents either agreed whole heartedly or agreed.

Q5: Due to the number of students, it would be extremely time consuming (and impractical) for the lecturer to assess the projects. The researcher was also interested in the scalability of this approach. Thus, the lecturer played a role of facilitation and if necessary moderation but not direct assessment. The lecturer provided an assessment schedule, criteria and guidelines, and was present at all four (4) three (3) hour assessment sessions. This question sought to gauge the student’s opinion on whether they felt the assessment process and assessors were fair.

In 2015, 66% and in 2017, 88% of respondents either agreed whole heartedly or agreed. The improvement was probably due to the fact that 2015 was the first year the course was run, and the assessment criteria were not as fully developed or as transparently available as in 2017. Also, by 2017 the tutors had been through the process themselves and probably were better able to assist and assess the project.

In 2015, 63% and in 2017, 81% of respondents either agreed whole heartedly or agreed that the project should form a greater component of their results.

Q7: The researcher wished to see whether the students felt that a graded MCQ assessment approach was fair. Previously the theoretical aspects of the course required the single lecturer responsible to single handedly mark each written examination (and two tests). Changing to an entirely MCQ based examination resulted in a saving on resources, as before marking an examination could take literally weeks. Automated marking reduced the time to minutes. In 2015, 71% and in 2017, 73% of respondents either agreed whole heartedly or agreed that the MCQ assessment was fairly applied. It should be noted that 18% did not feel the assessment to be fair using the approach.

Conclusion

The Approach as we have introduced it, is an attempt to introduce students to the various activities associated with the development of a product, from conceptualisation to completion in a Lean and Agile manner. The approach encourages an Agile mindset to be cultivated by all stakeholders. It is a lightweight adaptable approach in spirit, and it can (and should) be customised by any proponent to emphasise (and make rigorous) those deliverables most important to the educational goals required in a particular context. Overall students were supportive of this Approach, and it demonstrated scalability, it also counters common
problems like plagiarism and facilitates peer-based assessment, decreasing the work-load of the lecturer in terms of setting model solutions and evaluating voluminous individual projects.

**Future work**

Future evaluation of the Approach will focus on the actual deliverables such as the system metaphor, metaphor matrix, and crowdsourcing campaign to assess whether or not these were found to be helpful and effective by participants. Also, postgraduate students who are now employed in the industry may be surveyed to determine, on reflection whether they found the course content and processes to be relevant to the work environment.

Hopefully the Approach will inspire both educators and students to explore their own ideas and encourage self-reliance and entrepreneurialism, transforming participants experience, attitude and views of the educational experience. Above all, it is hoped that this research will contribute to the culture of maintaining an Agile mindset.

**References**

10. Examples of Projects and Project Presentations: https://www.youtube.com/watch?v=F4YRNcqRDh0&list=PLtdWw7c_7RegrHD3CVquPJ95LAj4BHD2U
Abstract

In South Africa, like in many other developing countries where access to basic healthcare services are limited, point-of-care technology to assist healthcare professionals with identifying symptoms associated with communicable and non-communicable diseases, is a major challenge. Without basic healthcare, the life expectancy and quality of life of citizens are limited and the burden of disease remains a challenge. Early detection of basic symptoms of communicable and non-communicable diseases, learning disabilities and sensory impairment are virtually impossible without qualified nurses or doctors in schools.

As a potential solution to the shortages of qualified physicians in rural communities, the Community Healthcare Worker—model (CHW) was implemented with the purpose to extend healthcare service delivery into under-serviced areas. Community healthcare workers are faced with many problems on a daily basis, which they have to solve on their own because clinics and other support structures are not readily accessible.

In order to make healthcare—and medical information more accessible to those with no or limited medical training, the Centre for Community Technologies at the Nelson Mandela University in South Africa, on research with the aim to develop a technology tool that will not only serve as a medical reference tool and educational platform for the users but also assist with the detection and monitoring of diseases. The need for such a tool was validated through previous research conducted by the research team, in partnership with government bodies and medical research institutions.

The technology tool that was developed is an integrated mobile application to up-skill community healthcare workers including nurses and clinic practitioners in areas where basic healthcare, first aid skills and clinics are scarce. The application allows for the early detection of various disabilities and diseases among children, child nutrition, chronic disease management, information on infectious and non-infectious diseases, first aid and various other conditions.

The aim is to integrate the application into existing national healthcare solutions to not only inform immediate action or response to a particular disease incidence but also inform long-term strategies for resource allocation to ensure effective continuum of care for all.

The application underwent strict user testing and became available in the public domain in May 2017.

Keywords: Point-of-Care Technology, Mobile Health App, Community Healthcare Workers.
Introduction

Like in many developing countries around the Globe, people living in remote areas in South Africa have limited access to basic healthcare services. The long distances they have to travel to get to a healthcare facility, the cost of transportation and the high cost of medical services are some of the common barriers that limit rural communities to get the care they need (Goudge et al, 2009).

In countries with high rates of maternal mortality, the proportion of childbirths attended by a skilled healthcare worker or midwife can be as low as 10%, while countries with low rates of maternal mortalities, have close to 100% deliveries attended by qualified health professionals (WHO, 2010). This presents great challenges for pregnant women living in rural communities or in the outskirts of towns where immediate or even timely access to medical assistance is just not viable. The doctor---to---population ratio is estimated to be 0.77 per 1 000 but because the majority of general practitioners (73%) work in the private sector, there is just one practicing doctor for every 4 219 people (Health Care in South Africa, 2012). Without access to basic healthcare services, maternal mortality rate is high and the risk of sickness and disease remains a challenge.

Community Healthcare Workers (CHWs) in rural environments face various challenges on a daily basis, including how to diagnose illnesses by identifying the signs and symptoms a patient presents as well as a lack of up to date information on communicable and non---communicable diseases. It is thus imperative to support CHWs with practical, relevant and easy to understand information at the point---of---care. It is against this backdrop that Ncediso™ was developed.

The Ncediso™ app is an integrated mobile application developed by the Centre for Community Technologies (CCT) at the Nelson Mandela Metropolitan University that gives users access to critical healthcare information at the point---of---care. Ncediso™ was developed to up---skill CHWs including nurses and clinic practitioners in areas where basic healthcare, first aid skills and clinics are scarce. The application allows for the early detection of various disabilities and diseases among children, child nutrition, chronic disease management, information on infectious and non---infectious diseases, first aid and various other conditions. Taking in account low literacy levels, language barriers and technology illiteracy, the app had to be simplistic enough for technology novices to find it pleasant to use but at the same time comprehensive enough to make a positive impact.

The need for such a tool has been validated through previous research conducted by the CCT in partnership with government bodies such as the Department of Health, the Department of Science and Technology and the Medical Research Council. The aim of Ncediso™ is not only to educate users but also assist with the detection, monitoring and evaluation of diseases to ensure effective continuum of care for all South Africans.

Ncediso™ is unique to the South African context as it offers integration with the Department of Health databases and monitoring systems. The application also offers interoperability between the different users. Ncediso™ underwent strict user testing and although the initial intended audience was CHWs in rural areas, it was found that members of the broader public
also found the App most useful. Ncediso™ has therefore been released in the public space where it can be downloaded, free of charge, from Google Play Store.

The purpose of this document is to report on the outcomes of Ncediso™, a mobile application for which Seed Funding was received from the Technology Innovation Agency (TIA), for the refinement and rollout of the app in more than 140 healthcare clinics across South Africa. This narrative includes the initial planning, design and development of the App as well as the testing and findings of the User Experience (UX) and Usability Evaluation of the App.

The document also outlines the findings of the Market Research conducted on the viability and sustainability of Ncediso™. The findings were used to evaluate the system, enhance user experience and determine price affordability of potential users.

Process

This section discusses the development process of Ncediso™. This includes the initial needs analysis with healthcare practitioners, the participatory design processes followed, the development of the prototypes and the rollout of the final product.

Needs Assessment

A Needs Assessment was done with various CHW groups, their supervisors as well as Professional Nurses, working in deep rural clinics. The objectives of the assessment were to understand the specific needs of healthcare professionals working in deep rural settings in terms of access to healthcare information; to identify the types of health conditions they encounter on a day-to-day basis and the healthcare topics most relevant to their specific environments as well as the professional development of healthcare workers and nursing staff.

The data collected was categorised as follows:

- The types of Non-Communicable Disease (NCD) services provided in rural communities
- The types of specialised healthcare services provided
- The types of general healthcare services provided
- What training and up-skillling are needed
- What challenges healthcare workers face on a daily basis
- What the barriers to essential healthcare service delivery are
- What can make their lives easier; and
- What their expectations are

Content Research

It was important to acquire evidence-based content. Various content and content providers were researched and it was decided to use the healthcare content developed by Hesperian Guidelines. Hesperian Health Guides is a NGO who produces and shares easy-to-understand health information for people worldwide (Werner, D. 2015).
The content was purchased and customised to suit the South African context. Taking into consideration potential literacy and language barriers, the content and how it is presented was designed in such a way that it was easy to understand and easy to navigate. Medical terminology was explained in layman’s terms and where possible, images and diagrams were used to explain, demonstrate and describe complex issues. All the images in the app were re-designed and contextualised to make it easier for users to relate to it.

**Requirement Specifications**

Based on the findings of the needs assessment, it was clear that a technology intervention in the form of a mobile application could assist the healthcare workers to overcome most of the challenges they were faced with. A user requirement analysis was done and from this analysis the functional and non-functional specifications for the application were determined. This in turn informed the design and development of a tool that could support the daily tasks of the healthcare workers.

The application was developed in English, as that is the business language used by most healthcare professionals, although provision was for multi-lingual capabilities in the future. Technology literacy challenges made simplistic designs and functionalities critical for the successful implementation of the app.

**Participatory Design**

Carroll and Rossen (Carroll et al, 2009) defined participatory design as the direct involvement of end-users in the development of information systems and applications. They argued that these end-users, who are affected most directly by a design outcome, should have a significant say in the design of the outcome. It was thus critical to consult potential end-users during the design process of the application to ensure that the app will meet the expectations of the users in order for it to be used on a long-term basis.

Feedback from potential end-users is of critical importance during user interface design processes. A comparative evaluation was thus done between two different prototypes with different interface designs. The objective of the evaluation was to take a closer look at the different aspects of the two interfaces and that the users were either uncomfortable with or had difficulty with.

**Comparative Testing**

*Comparative testing evaluates the strengths and weaknesses of two or or products or designs based on users’ actual experiences* (TECED, 2016). In order to understand what users want from the app, what the preferrable features and functionalities should be and what the users will compromise and what not, a comparative evaluation were done with two different prototypes with regard to the following factors:

- Interfaces of the prototypes in terms of aesthetics, screen layout, usage and interpretation of images and icons etc.
• Accessibility of the information on the app in terms of difficulty factors, time and ease of finding the information they were looking for.
• Navigation in terms of moving through the different screens, aptness of the workflow etc.
• Usefulness with regard to the content.
• User Experience i.e. likability, user-friendliness, language and terminology.

From the observations and comments during testing, the users initially seemed to be lost when trying to navigate the application from the main menu. This was due to the limited options in the main menu as well as the general layout being different to what they were used to. The users made valuable recommendations with regard to the colour scheme of the interface, the size of the text and the screen layout. These recommendations were implemented and a new interface was designed, which looked fresh, was simplistic, less cluttered and more user friendly (Veldsman, van Greunen, 2017).

**Development Phases**

The development of the Ncediso™ was done in 5 phases:
- Phase 1: Navigational Prototype
- Phase 2: Initial Content Prototype
- Phase 3: Application Completed
- Phase 4: Software Testing
- Phase 5: Final Release Candidate

![Figure 1: Ncediso™ – development phases](image-url)
Navigational Prototype

Phase 1 was the development of a Navigational Prototype, which was a working implementation of the co-developed design. The implementation contained no content beyond the menu/navigational structure and the envisioned colour and layout scheme. Once the Navigational Prototype was approved and signed-off, the 2nd phase of the development could start.

Content Prototype

Phase 2 was the development of the initial Content Prototype, which was a fully implemented topic with all associated navigational steps associated with accessing a specific topic. With the Content Prototype, the functionality and layout of the screens were tested and proposed changes made. The final version of the implemented topic was used as a template for the next phase of development.

Application Completion

A partially implemented Android Application was delivered in the form of an APK (Android Package Kit) for comments and updates during Phase 3 of the development cycle.

Software Testing

Software testing was done on the fully implemented Android application during Phase 4, to identify any discrepancies not noticed during testing in Phase 3 and to make any changes required.

Final Release Candidate (RC)

Phase 5 marked the delivery of the fully implemented Android Application that is available on Google Play Store from where it could be downloaded.

User Experience Evaluation

User Experience (UX) refers to a person’s emotions and attitudes about a system, product or services when interacting with it in particular conditions (Arhippainen, 2003) (Norman & Nielson, 2017). In terms of technology, a good UX will ensure adoption and continued use of the technology. It was thus important to evaluate the users’ UX towards the app to ensure that it added value regardless of potential users’ background.

User Profiles

A total number of 61 users participated in the UX evaluation of Ncediso™. Evaluations were done with smaller user groups comprising of medical professionals and those without a medical
background as well as tech-savvy users and technically illiterate users. A Random Sampling method was used to select the reviewers.

Reviewers were between ages 18 and 65 years and the majority was female. The users came from a wide spectrum of professions and backgrounds i.e. Professional nurses, clinicians, academics, teachers, students, scholars, unemployed and self-employed individuals. All the users could use or owned a mobile phone. The type of devices they used varied from feature phones to Smart phones but the majority were Android devices. The users’ level of technology proficiency also varied. While the more senior users, just received calls and text messages via their phones, the younger users could download music and apps and access a variety of services from their phones depending on the functions of the devices i.e. online banking, surfing the Internet and do online shopping.

Similar characteristics were presented in terms of computer literacy and computer usage. Windows-based software, Android Apps, Microsoft Office products and a variety of Internet engines were popular whereas iPhones Apps, Apple Mac software and Google Apps for Business were less used.

**Objectives of the Evaluation**

The objectives of the evaluation were to determine the following:

- Diversity of professions
- Age range of participants
- Devices participants are familiar with
- Type of mobile primarily used by participants
- Software tools used on a regular basis by participants
- Usability of the application in terms of:
  - User expectations (anticipation prior to interacting with the app);
  - Interaction with the app itself;
  - Impressions after interacting with the app (emotional identification or distancing)
  - Content relevance

**Evaluation Criteria**

The users evaluated Ncediso™ against the following criteria:

- User satisfaction, which relates to the users’ feelings, perceptions and opinions of the app.
- Aesthetics, which refers to visual design with regard to layout, fonts, letter size, colours etc.
- Navigation, which relates to the ease of finding the desired information.
• Usability, which refers to the users’ ability to achieve specific goals as well as the willingness to use the app.

• Efficiency, which refers to the time it takes a user to complete a task as well as the precision with which the task is performed.

• Effectiveness, which would indicate if the user could successfully get the desired outcome.

• Valuable, which will be an indicator for the continued use of the App.

• Content, which indicates whether the potential user feels that the appropriate content was used in the application and whether the information was easy to understand.

**Evaluation Methods**

Mixed methods were used for UX testing and content evaluation i.e. focus groups, user observations with tasks, time---based user tasks, questionnaires and online surveys.

Participants were sent the APK of the application via email or the URL was given to them during the focus group sessions. The app was then installed onto their Android phones. Instructions on how to download the application were given. Since some of the users found it easier to follow the installation instructions in their mother tongue, the instructions were translated in the preferred language.

Participants were given a set of tasks to complete that would require them to navigate their way around the app. The moderators observed the users while they interacted with the app to assess the usability, learnability, navigation, efficiency and effectiveness with which they completed the tasks as well as the time it took them to perform the tasks. The users then completed a questionnaire with statements regarding their interaction and experience with the app.

Users who had Internet access and who could successfully install the app onto their mobile phones completed online surveys. These surveys were then analysed and the findings documented.

**Results and Findings of UX Evaluation**

For the questionnaires and online surveys, key statements were put forward to the users in order to evaluate the level of UX each individual user had with the application. The users were asked to indicate their level of agreement to the statements using a Likert Scale.

**UX Evaluation Results**

The following key statements were put forward to evaluate the UX regarding the app itself.
• The application easy to work with
• Navigating between the screens of the application were easy
• Find information was easy
• Colours are appealing

• Language is easy to understand
• Medical terms are easy to understand
• The size of text is appropriate
• Using the application was a good experience

The respondents were asked to indicate their level of agreement with the given statements by way of an ordinal scale, with 5 levels from Strongly Disagree to Strongly Agree. The majority of the respondents Strongly Agreed with the key statements, with the exception of the understandability the medical terms, which some of the respondents had difficulty with.

The findings for each statement were as follows:

• The majority of respondents Strongly Agreed that the application was easy to work with. An even number of respondents Moderately Agreed and Agreed. Only one respondent found the app difficult to work with.
• The majority of respondents Strongly Agreed that navigating the different screens of the app was easy. The remainder of the respondents Moderately Agreed and Agreed with Moderately Agree leading by one.
• The majority of respondents Strongly Agreed that it was easy to find information on a specific condition in the app. The remainder of the respondents Moderately Agreed and Agreed with Agreed leading by two votes.
• The majority of respondents Strongly Agreed that the colour scheme of the app is appealing. Few respondents Moderately Agreed; Agreed and Disagreed.
• The majority of respondents Strongly Agreed that the language used were easy to understand. The remainder of the respondents Moderately Agreed and Agreed with Agree leading by one.
• The majority of respondents Moderately Agreed regarding the understandability of the medical terminology used in the app. Fewer Agreed and Strongly Agreed.
• The majority of respondents Strongly Agreed that the text size is easy to read. Few respondents Moderately Agreed and one respondent found the text too small and difficult to read.
• The majority of respondents Strongly Agreed that using the app was a good experience. The remainder of the respondents Moderately Agreed and Agreed with Agreed leading by one vote. Only one respondent did not have a good user experience

Content Evaluation Results
The following key statements were put forward to evaluate the appropriateness and usefulness of the app.

- The content in the application is appropriate
- The information in the application is useful
- Information and instructions in the application are clear and easy to follow
- I will be able to apply the information when needed
- The hyperlinks help to find more detailed information, fast
- The images are relevant to the different topics

The respondents were asked to indicate their level of agreement with the given statements by way of an ordinal scale, with 5 levels from Strongly Disagree to Strongly Agree. The majority of the respondents Strongly Agreed with the key statements, with the exception of the clarity of the information and instructions given in the app as well as the usefulness of the hyperlinks, which users had difficulty with. The findings for each statement were as follows:

- The majority of respondents Strongly Agreed and Agreed that the content in Ncediso™ is appropriate, with Agreed leading by one vote. The remainder of respondents Moderately Agreed.
- The majority of respondents Strongly Agreed and Agreed that the information is useful, with Agreed leading by one vote. The remainder of respondents Moderately Agreed.
- The majority of respondents Strongly Agreed and Agreed that the information is useful, with Agreed leading by one vote. The remainder of respondents Moderately Agreed.
- The majority of respondents Agreed that the information and instructions are clear and easy to follow. An even number of respondents Moderately Agreed and Strongly Agreed. One respondent found the information and instructions unclear and difficult to follow.
- The majority of respondents Strongly Agreed and Agreed that they will be able to apply the information when needed. A few respondents only Moderately Agreed with the statement.
- The majority of respondents Agreed that the information and instructions are clear and easy to follow. An even number of respondents Moderately Agreed and Strongly Agreed. One respondent found the information and instructions unclear and difficult to follow.
- The majority of respondents Agreed that the hyperlinks used in the app helped them to find additional information fast. The remainder of the respondents did not find the hyperlinks helpful.
- The majority of respondents Agreed that the images used in the app are appropriate and relevant. The remainder of the respondents Strongly Agreed and two respondents Moderately Agreed with the statement.

Market Research
A Market Research was effected in parallel with the UX evaluations in order to understand potential user profiles, determine the long-term sustainability of the app and the suitability of the app to users from various backgrounds, professions and geographical areas. Users provided valuable input from an end-user perspective such as marketability of the product, price of the app should it become commercially available, the impact it could have and recommendations to ensure continued use of the app.

**Objectives of Market Research**

The objectives of the Market Research were to:

- Determine if app is useful in both rural and urban settings;
- Determine the age groups of potential users to which Ncediso™ will appeal to;
- Determine if the app appeals to both male and female users;
- Determine if the app is useful to people working in the healthcare space only or to the broader public as well;
- Determine which information in the app users finds most useful;
- Determine what users expect to pay for the app;
- Determine what users are willing to pay for the app.

**Market Research Methods**

The users interacted with Ncediso™ following the same method as for the UX evaluation in order to have a consistent experience. Thereafter a market research questionnaire was completed. The questionnaire was constructed in such a way that all the objectives if the market research were reached.

**Results and Findings of the Marker Research**

**User Profiles**

Thirty people participated in the market research of which 9 were male and 21 female. Of the 30 participants, 8 were from urban areas, 6 from suburban areas, 6 from “townships”, which refers to under-developed urban areas typically on the periphery of a town or city, 3 were from informal settlements and 7 from rural communities. Eleven participants were between the ages of 18 and 24 years, 6 between 25 and 34 years, 6 between 35 and 44 years, 6 between 45 and 54 years and one participant was between age 55 and 64 years of age. The were no participants older than 65 years. The participants were from different backgrounds and professions.

**Usefulness of Content**
The users rated the topics on “Nutrition” the most useful in the app following by the topics “How to examine a sick person” and “How to take care of a sick person”. All the participants indicated that they would download the application when it become available and furthermore stated that they would recommend the application to people they know.

*Monetary Value*

Users’ opinions of the expected purchase price varied, as the majority of participants indicated that the application should be free and others indicated a price range between R4.99 and R14.99.

*Lessons Learnt*

Although the UX evaluations and Market Research were very encouraging, specific problem areas were identified, which could impact negatively on the users of the app. These problem areas were addressed in the development phases of the app.

*Lack of Technical Knowledge*

It was evident throughout the research process that even basic technological knowledge was lacking in some of the users. The measures taken to mitigate this challenge resulted in simpler instructions given to assist users in use the app. It was also noted that age played a factor in the challenge of technological knowledge and usage.
**Application Navigation**

Navigating the app was initially difficult for some of the users as it used a “Scroll function”, which some users were unfamiliar with. The scroll function was necessary due to the large amount of information in the app. In order to mitigate this problem and make navigation easier, an instructional tool in the form of a “Splash Screen” was added before the Homepage of the app, to demonstrate the scrolling action by using animations, which were easy to understand.

**Training and Facilitation**

Some of the users indicated that healthcare workers in deep rural environments would have to be trained to incorporate the use of technology in their daily tasks of caring for their patients to make them more comfortable using applications such as Ncediso™.

**Languages and Content**

The language and descriptions in the app was contextualised to allow for non-—medically trained persons to understand the information and instructions given. Users however wanted even more simplistic medical terminologies, which was not always possible. The language and content concerns were addressed by incorporating detailed descriptions and instructions in a non---medical format to support the medical terminologies. The images used in the body of content, served as visual aids. It assisted to identify conditions by illustrating what a condition could potentially look like and gave instructions on how to treat the condition. All the images were re-designed for the South African social context to allow users to relate to the images better.

**User Participation**

User participation during the review phases was initially a challenge as communications were mostly done through email. Adaptation to physical interaction with reviewers had to be implemented, which resulted in a smoother process. Installation procedures were developed in English and isiXhosa during the testing phase, in order to assist reviewers to download the app from where it was initially hosted. This proved to be viable and smoothed---out installations issues prior to the app being available on Google Play Store.

**Conclusion**

Ncediso™ fills an important gap in healthcare service delivery in under-serviced communities in South Africa. Feedback from the Department of Health is very positive and requests to develop similar applications to address other needs in the healthcare space, has been identified.

The overall UX evaluation results and Market Research results showed that Ncediso™ is a good product. This is depicted through the reviews of the UX, indicating a general satisfaction of the product. The Market Research also indicated that people would download the application when it becomes available on Google Play Store.
It is ultimately our aim to expand the app by including more healthcare information on topics identified by healthcare practitioners, in order to empower users to make informed decisions when faced with a difficult situation.

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