

Towards Sustainable Development with Prototyping to Enhance In-house Development of Information Systems in Developing Countries

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Abstract: Information Systems development have undoubtedly contributed towards development and sustainability in advanced countries and have also transformed the use of computers and related devices in different parts of the world in the last few centuries. It thus deserves attention to bring progress to society, increasing the standard of living with benefits related to quality of life through the development of knowledge, products, and services with the ultimate goal of sustainable development. Notable areas and fields of works in which Information Systems development have undoubtedly contributed towards includes organizational payroll systems, e-commerce, online banking, online bookings of different services, communication systems, e-learning and virtual learning systems etc. Most of these systems are developed in advanced countries and developing countries purchase at exorbitant foreign currency-based prices, the few of them that they even venture to use. However, it has now become well known how countries like India has leapfrogged towards development through progress in Information Systems development such that even advanced countries outsource some of their system development works to India to make use of their massive human talents at lower costs. Without doubt, this would have increased employment rate in India. This should serve a blueprint to many other developing countries that are especially low in financial fundings, plagued with high unemployment but yet buoyant with high human capital. But many developing countries are not seizing such opportunities. We believe actions speaks louder than voice and individual actions can collectively and ultimately bring development and sustainability. This study adopts a qualitative research approach using a systematic literature study of various previous studies that we have done in the past which adopted prototyping research and related methods. More specifically, the multiple methods for the various component studies include literature study, survey, argumentation, prototyping, participatory design and the design science method in the development of various systems we considered necessary to stimulate or leapfrog developing countries into sustainable development. Most of the system development works presented thus serves as prototypes. Argumentations are then often used in reasoning about some aspects of developed prototype systems to justify how those aspects could fulfil certain user objectives. Thus, in essence, the term argument is used to refer to our entire reasoning about some aspects of some Information system, or how those aspects could possibly affect the society positively and how negative implications can be resolved. Few things are apparent in this study. One is that given the low financial situations, proactive actions and decisions need to be taken for developing countries not to be left out of sustainable development. Secondly, developing countries need to adopt both single double-loop learning that promotes “doing things better” perspective as well as double loop learning that promotes “doing things differently” perspective. This will include seriously striving to benefit from the open-source initiatives saving costs and enabling learning through the openness of software programming codes, thus encouraging in-house development of information systems. Thus, we posit that sustainable development in developing countries is possible through progresses enabled by effective development and utilizations of Information systems at individual, organizational and societal level. And critical to this is continuous “learning and doing” leading to entrenched culture of using prototyping to effect “small wins” towards using

Information Systems development for competitive advantage towards enabling sustainable development.

Keywords: Competitive advantage, Information systems development, in-house development, prototyping, sustainable development

Introduction

Development can be in simple terms be understood to refer to a state of improvement. This is a desirable state for any society. Mansell and Wehn (1998, p.13) explain that while there is no 'holygrail' offering a clear definition of the meaning of development, it has been understood since the second World War to involve economic growth, increases in per capita income, and attainment of a standard of living equivalent to that of the industrialised countries. This was desirable to be achieved without incurring major social costs. An important aspiration of people is to sustain the state of development they might be, and to continue to grow more into further developmental state. Brown (2017) explains that sustainable development (SD) is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Milton (1992) indicates that most writers concentrate primarily on sustainability rather than sustainable development by focusing more on how current constraints can be overcome and the standard of living maintained.

Alcaraz and Bell (2014) explains that sustainability includes social, ecological, and economic principles, which are connected to the quality of life of society, ecological and social justice, and economic opportunities. Quality of life of society refers to human development, social and ecological justice, as well as welfare economics. In this sense, it is vital that new products and services introduced to society should cover a social, ecological, and economic benefit for users. New products and services introduced to society enabled by technology and innovation have benefits related to quality of life through the development of knowledge enabling such products, and services.

Enormous knowledge has been expended and gained over the years since the introduction of computers, enabling miniaturization of computer facilities while increasing the scope of services enabled by computers. Much progress has been made in the computerization of different aspects of life today. This is based on the potential that technological development and innovation in computerization bring automation to the society overcoming human limitations such as fatigue, consistency, reliability etc.

The resulting effect is that of the ability of people to delegate more tasks to the computerization process while enabling them to have time to do other important things in life. I recall some time about 3 decades ago when you have to take time off work and rush to the bank before they close around 3pm. This involves losing productive time at work and thus possibly losing income also. It also involves expending costs in driving to the bank, as well as environmental degradation due to fuel consumption as well as car emissions. Today, you can use internet banking to complete such banking task in seconds, saving such remaining time to have time to do other important things in life. For further example, the convergence of computerization with telecommunications today could enable intercontinental virtual meeting saving costs worth thousands of dollars, as well as reducing environmental degradation. This in essence could lead to increasing the standard of living and with ecological benefits i.e. resulting in less damage to the environment.

But for these innovation in technologies to work effectively, computer programming efforts are involved in converting data to more meaningful information leading to greater heights in Information Systems development. Thus, technological development and innovation in Information Systems development undoubtedly deserve attention in this regard.

Notable areas and fields of works in which Information Systems development have undoubtedly contributed towards includes organizational payroll systems, e-commerce, online banking, online bookings of different services, communication systems, e-learning and virtual learning systems etc. With the aid of Information Systems development, Mansell and Wehn (1998, p.9) explain that certain firms have dramatically improved their competitiveness by using ICTs and some developing countries are increasing their export strengths in the ICT sector. Some governments in the developing world are providing services to their citizens more efficiently using the new services.

Most of these systems are developed in advanced countries and developing countries purchase them at exorbitant foreign currency-based prices, the few of them that they even venture to use. However, it has now become well known how countries like India has leapfrogged towards development through progress in Information Systems development such that even advanced countries outsource some of their system development works to India to make use of their massive human talents at lower costs. Without doubt, this would have increased employment rate in India. This should

serve a blueprint to many other developing countries that are especially low in financial fundings, plagued with high unemployment yet buoyant with high human capital. But many developing countries are not seizing such opportunities.

But many developing countries are yet to tap into the benefits offered by the creation and diffusion of scientific knowledge and technologies such as Information Systems. Mansell and Wehn (1998:9) explain that the least developed countries are at risk of being excluded from knowledge-based development.

Alcamo and Bennett (2003) indicates that “the creation and diffusion of scientific knowledge and technologies can have relevant implications for socio-ecological systems“. In response to that, Alcaraz and Bell (2014) observes that “for this reason, institutions and governments must address policies involving research, development, social learning, and the transfer and commercialization of technology and knowledge”.

So, for the creation and diffusion of scientific knowledge and technologies to have relevant implications for socio-ecological systems, it is important to know how institutions and governments are faring in this regard. Mansell and Wehn (1998, p.11) observe that developing countries are at very different starting positions in the task of building innovative and distinctive 'knowledge societies' and in using their national information infrastructures to support their development objectives and efforts. Mansell and Wehn (1998, p.11) ask: Are the stakeholders in developing countries taking appropriate measures to maximize the benefits of ICTs for development? Are the stakeholders in developing countries taking appropriate measures to minimise the risks of social and economic exclusion that could be associated with these revolutionary technologies? One of such risks is unemployment resulting from using computers to do what many people would have been required to do. So, are the stakeholders in developing countries taking appropriate measures to retrain people in other areas that would contribute to the computerization efforts? If not, then we are in a double trouble situation because since most of these systems are developed in advanced countries and developing countries purchase them at exorbitant foreign currency-based prices, then developing countries loose money and also loose jobs, since a computer can do what many people would have been required to do.

However, compare that situation to the case of India which has leapfrogged towards development through progress in Information Systems development such that even advanced countries outsource some of their system development works to India to make use of their massive human talents at lower costs. Without doubt, this would have increased employment rate in India. This should serve a blueprint to many other developing countries that are especially low in financial fundings, plagued with high unemployment but yet buoyant with high human capital. But many developing countries are not seizing such opportunities.

The above situations are central to understanding the social, ecological, and economic impact of ICTs towards development and sustainability. We believe actions speaks louder than voice and individual actions can collectively and ultimately bring development and sustainability. We need different efforts to enhance knowledge and motivate people that will develop the various information systems needed. This would require continuous “learning, doing and further learning” to ensure sustainable efforts enabled by research. As we develop systems to computerize certain tasks, we need to continuously reflect on it and learn more on doing better and even learning from users as they test-run the developed systems. Traditional software development lifecycle like the waterfall approach may not incorporate continuous learning efforts enabled by such research and learning. Olivier (2009, p.4) indicates that simply developing a system does not constitute research but rather engineering projects as different principles, approaches and goals apply. On the other hand, it is clear that methods such as participatory design would enable continuous learning from users as they participate in the design and development efforts. A particular method usable in as participatory design is prototyping.

Olivier (2009, p.51) explains that prototyping enables design of prototypes which are simplified version of the proposed system, that serves as a guide or example for the complete program or system that can then be used to explore further characteristics of the system. In comparing prototypes to models, Olivier (2009, p.9) explains that the construction of a prototype may provide more new insights into the prototyped model than those gained from the model alone. Users can use and play around the features and the “look and feel” of the prototype and learn from it and use it to propose enhancements. This way, users are actively participating in the design and development efforts. And apart from users, the developers can also use the prototype to explore further characteristics of the system and learn from it and use it to enhance the systems. These explorations are done on currently active projects. But more effectively, researchers and software developers who have used prototyping in previous projects can still reflect on the previous projects in order to seek how to enhance possible adoption of such systems towards ensuring effective societal utilizations of useful developed systems. In this regard therefore, this study seeks to examine multiple perspectives of innovation for sustainability, and to also discuss various previous studies that we have conducted using

prototyping and related methods and seek how to enhance possible adoption of such systems in order to stimulate or leapfrog developing countries into sustainable development.

This study therefore fits into the three primary strategies suggested by Olivier (2009, p.1-2) for conducting research. Olivier (2009, p.1) indicates that the first involves compiling information on some topic, where the bits and pieces have already been discovered, but where the bits and pieces have not yet been integrated into a single coherent body of knowledge. This study reflects on prototyping as used in our previous in order to integrate them into a single coherent body of knowledge that seeks how to enhance possible adoption of such systems. The second strategy for conducting research according to Olivier (2009, p.2) involves solving a problem for which no known (or apparent) solution exists. No known (or apparent) solution exists yet on why many developing countries are yet to be leapfrogged towards development like India has, through progress in Information Systems development such that even advanced countries outsource some of their system development works to India to make use of their massive human talents at lower costs.

The third strategy according to Olivier (2009, p.2) involves looking at existing knowledge with new eyes. In other words, possibly using additional methods towards finding a better solution for a problem that has previously been solved. This study also fits into this third primary strategy by using additional methods such as argumentation to reflect on prototyping methodology and participatory design as used in previous studies towards finding a better solution for the problem on why many developing countries are yet to be leapfrogged towards sustainable development even as the whole world strive to create a new order enabled with progresses in computerization and the use of Information systems development. Furthermore, Olivier (2009, p.3) indicates that the problem-solving process is iterative by nature. Therefore, one can move from any of these strategies to another in a particular order and can iterate as necessary until developing countries reach a desirable state of development and sustain such state of development. The next section therefore presents the methods for obtaining the answers that this study seeks.

Materials and Methods

This study adopts a qualitative research approach using a systematic literature study and synthesizing of various previous studies that we have done in the past which adopted prototyping research and related methods. This is akin to Meta-analysis as a methodology employed to synthesize the outcomes of various studies related to the same topic or outcome measured (Gooty, Banks, Loignon, Tonidandel & Williams, 2021). More specifically, the multiple methods for the various component studies include literature survey, argumentation, prototyping, participatory design and the Design science method in the development of various systems we considered necessary to stimulate or leapfrog developing countries into sustainable development. Most of the system development works presented serves as prototypes. Olivier (2009, p.51) explains that the term *prototype* refers to a simplified program or system that serves as a guide or example for the complete program or system. One presents the prototype to make the statement that it is also possible to implement certain concept in practice. Olivier (2009, p.52) observes that in using prototyping, one will still have to argue (or otherwise demonstrate) that the model does indeed have merit and one can then always use the prototype as proof of a concept.

Argumentations are then often used in reasoning about some aspects of developed prototype system to justify how those aspects could fulfil certain user objectives. According to Olivier (2009, p.105), some research projects rely primarily on arguments to support their conclusions. Olivier (2009, p.9) further notes that any research will include some reasoning. For example, it is sometimes necessary to present some argument as to why one alternative is better than the other. Such an argument may range from stating an obvious fact to detailed reasoning pointing out and combining many subtle issues. Thus Olivier (2009, p.105) states that an argument simply combines existing facts to derive new facts. Thus, in essence, the term argument may be used to refer to one's entire reasoning about some aspects of a system, or how those aspects could possibly affect the society.

Ultimately, the approach and methods aim to explore how sustainable development could stem from actions and beliefs, innovation for sustainability, and learning interactions of key stakeholders. Thus, we use a bottom-up and top-down methodology, with the goal of identifying the problems, perceptions, benefits, etc. of the stakeholders involved achieving sustainable use of information systems and web application development for competitive advantage towards sustainable development in developing countries.

Results and Discussion

As indicated in the previous sections, by examining multiple perspectives of innovation for sustainability, as well as the benefits of learning interactions, we discuss various previous studies using different methods especially prototyping and related methods that we consider necessary to stimulate or leapfrog developing countries into

sustainable development through progresses in Information Systems development. The next sub sections discuss these various previous studies we conducted within the past 20 years in line with two of our ICT faculty's research niche areas named ICT for Development (ICT4D) and ICT for Business Enhancement (ICT4BE).

Enhancing the use of the Internet and web applications for development in South Africa

In the early days of the use of the Internet and web applications in South Africa, we observe that the use of the Internet and web applications holds the ability to increase performance in activities such as online assessment, online bookings, online banking etc. Yet the use of such innovation seems to be gaining popularity at a very slow pace. Even in institutions of higher education like the then Technikon Northern Gauteng -TNG (which now combined with three other Technikons to form the Tshwane University of Technology in 2004), paper tests were still commonly used. Dehinbo (2004) was then conducted to study "the impact of web-based middlewares on training and assessment through in-house developed on-line testing system at TNG".

Dehinbo (2004) is aimed at determining the impact that web-based middleware systems can imprint in enhancing learning and assessment. Survey, modelling, and prototyping methodologies were used. Representative samples of students attending introductory computer classes at the Technikon, were assessed to determine the level of their knowledge and use of the Internet. The alternate hypothesis is that changing to an on-line test may improve the Internet knowledge of the students.

Only few of them demonstrate high Internet knowledge and awareness. Over 80% indicate willingness to use the Internet and surf the Web more, if there is a compelling situation that forces or encourages them to do so. One group of students were given assignments and tests throughout the semester via the on-line prototype system developed and were subsequently reassessed at the end of the semester.

The prototype system developed uses the client-server model and examines how to construct a communication path between the web browser in a client, web server, servlets written in Java and the database through Java Data Base Connectivity (JDBC) or a flat text file. The study ends with the implementation of the school assignment system whereby students can connect online for the answering and submission of assignments through the World Wide Web. The client can then fill-in his or her name and student number, as well as the answers to the questions online. There are different types of questions represented viz; Multiple choice; Mix and Match; Fill-in the missing words; Definitions and explanations

On clicking submit after completing the assignment, the servlet creates an ASCII file. The file will contain the student's name, student number, the IP number or the host name of the client computer from which the answers are filled. These are stored in this file and kept in the tomcat directory on the server, for the lecturer to mark later.

While a student is answering the assignments on the web, there is a great likelihood of getting more familiar with the use of the Internet as source of valuable information. The online assignment and testing software is therefore expected to propel students to work on the Internet. The result showed dramatic improvement in the level of their knowledge and use of the Internet as well as increased speed of carrying out assigned tasks on the Internet. The study concludes there is a huge impact that web-based middleware can imprint in enhancing learning even in contact institutions.

What then? If the system led to improving the quality of Internet knowledge of students, what then can be done so it can benefit the community? The result led to my idea in the participation by a team of 6 members of staff, in a project to equip an "Internet open lab" and conduct computer trainings for staff and students in IT applications like MsOffice and Programming (HTML, C++, Java, VB, ASP using VBScript). This was fortunately funded by USAID to the tune of R1 million (US\$147,000.00 as at that time). The project was completed in August 2003, but the lab continues to serve the University community in the Soshanguve campus till today. This is an example of how research can bring developmental funding to a society, if only the next generation can learn and build upon such work to ensure sustainability.

And more interestingly, as I was drafting this article, I wondered if the article would still be available online, being my first international research paper, presented in Australia and published over 18 years ago in June 2004. Then I clicked on the Web site link <http://proceedings.informingscience.org/InSITE2004/027dehin.pdf> for the article, and behold, the article comes straight on my screen. This is a further illustration of the enormous impact that Information systems can wield towards development. Imagine if I had to start searching for the article on my study shelves, or better still, imagine millions of people that could have accessed the document all over the world in seconds? Why wont a serious government and a serious society take such technology that facilitates this development of Information systems and web applications seriously for the benefit of the whole society?

And towards widely developing web applications more efficiently, Dehinbo (2005a) was conducted to study the performance of web-based 2-tier middleware systems. The latency experimentation aims to estimate the performance by estimating the response time or execution speed for programs written using each of the dynamic Web platforms Java Servlets, Java Server Pages (JSP), Active Server Pages (ASP), and Personal Home Page (PHP) in order to gain information on the suitability of these platforms for recurrent program testing in a practical laboratory session. We also measure the performance together with scaling while increasing the size of a database. Therefore, prototyping, modelling and simulation are three methods used as the prototype also serves as model for simulation of performance as the size of a database increases.

It should be pointed out that users of the framework can conduct their own latency experimentation. Dehinbo (2005a) presents the full details of this experimentation, but below is a brief discussion of the latency experimentation, starting with the system configuration and the database configuration for the experimentation. The architecture adopted is a three-tier system in figure 1, with the client browser connecting to the server which also hosts the Database Management System.

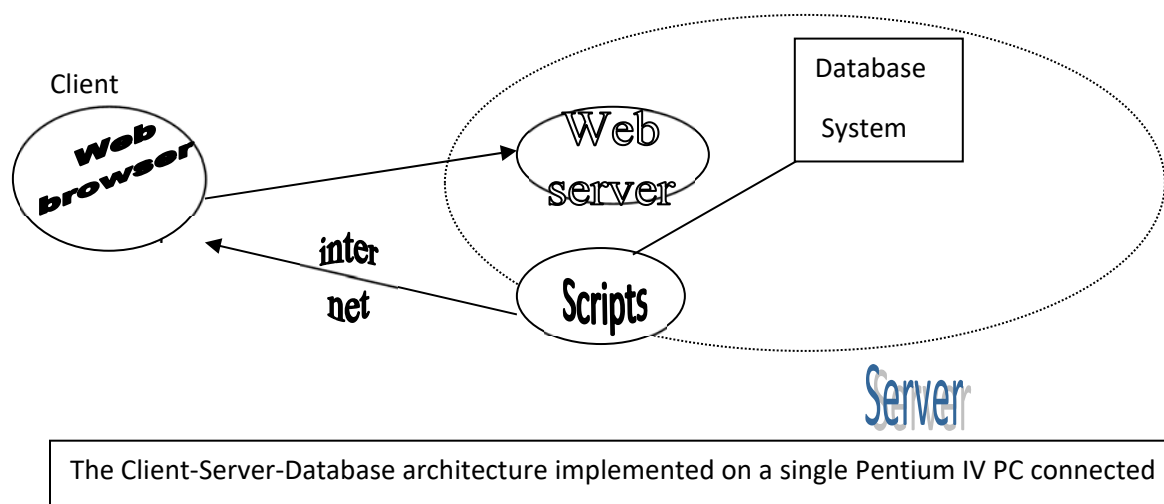


Fig. 1: Typical configuration for a three-tier architecture

In order to estimate the time taken to access and display data from the database, a database is created for all the platforms using Microsoft Access 2000. Program execution begins with 10000 records, and then doubled the size of the database to 20000, then to 40000 and then to 80000 records. This is simply because it is easier to duplicate the whole records than to enter new records, and also so that scalability can be measured as database size increases.

An algorithm is designed to access and display all the stored records in the database. This algorithm is then translated into a program written in the various platforms compared in the testing of the framework. Each of these programs extract the system time at the entry point of the program as “starttime”, and extract as “stoptime” the system time at the end of the program. The difference between the “starttime” and the “stoptime” in seconds is taken as the estimated time for the database retrieval operation. This is used as an estimate of the latency value for the dynamic Web platform. The experiment is performed twice in order to use the average value.

Given below are the results of the latency experimentation presented at the *Informing Science + Information Technology Education (InSITE) 2005* conference in Arizona, USA, and published as a full paper in the conference associated Journal. PHP’s better performance is due to the fact that it executes as a module in the Web server, sharing the same process (address space), thereby minimizing communication overhead between the Web server and the scripts. This is unlike Java Servlets which runs in a Java Virtual Machine as a separate process from the Web server.

And also, towards widely developing web applications with ease and thus more efficiently, Dehinbo (2005b) develops a framework for the evaluation of the ease of use of Web-based dynamic platforms. While this did not use prototyping, it is aimed at working along with other prototyping studies by ensuring that such prototypes web applications are developed with ease and thus more efficiently.

And more interestingly again, as I was drafting this article, I clicked on the Web site link <http://www.uj.ac.za/www2005/documents/DehinboJO.pdf> for the Dehinbo (2005b) article, and *behold*, the message “file not found” comes straight on my screen. This article was presented at the www conference in Cape Town in 2005 and hosted on the sub-domain for the University of Johannesburg, as aided by a late professor. Probably after the death of the Professor, some people in management decided to remove the proceedings. This is an illustration of how some developing countries don't take some things that can lead to development seriously. Hopefully, future generation of leaders reading this article would take such technology that facilitates development of Information systems and web applications seriously.

And still in the spirit of widely developing web applications more efficiently, we recognize that future information systems and web developers are today's students and as such, they need to be taught programming using a very suitable programming language. Dehinbo (2006a) thus presents a study on determining a suitable programming language for the B.Tech. degree in Computer studies department of the Technikon Northern Gauteng (TNG then). Similarly, Dehinbo (2006b) is a study towards a framework for determining suitable platform for teaching Web application Development in tertiary institutions in South Africa. PHP emerged as the most suitable programming platform. Among the various characteristics of PHP are the “variant data type” that do not give syntax errors when integers and floating-point numbers with decimal point (e.g. 2 + 3.0) are mixed in an expression. Avoiding such flimsy errors could allow software developers to concentrate on more important concepts in Information systems development.

At this point, we observe that the use of the Internet and web applications and related innovations in South Africa then seem to be gaining popularity at a quicker pace. However, much emphasis seems to be on purchasing from abroad or importing various applications in higher currencies. We note that such is not sustainable in developing countries given the low availability of financial fundings yet having high human capital. Dehinbo (2007) thus presents a study titled “*Dancing to the tune of in-house Web application development: the case of a South African University*”.

Dehinbo (2007) aims to address the research question on how do we progressively take advantage of the recent opportunities provided by the use of Web platforms and Web applications in the teaching to undergraduate students as well as in the adoption and use of Web applications in tertiary institutions in developing countries? The main benefit of the study will be the enhancement of the teaching of Web application development, thereby increasing the students' potentials in such a way that would lead to higher productivity in the software development and services industries

Dehinbo (2007) explains the problem leading to the study. These are given below:

a) Problem of document transfer

This involves problems encountered in handling students' examination answers saved in floppy disks. Until around 2006, many disks were purchased and given to students during tests and exams. Practical solutions to the test questions were stored on the disks and submitted to the lecturers. The durability and quality of such disks is also compounded by the ignorance on the handling and care of the disks. Manufacturers always write the rules such as “do not bend”, “do not place close to magnet”, “do not touch the exposed parts” etc. However, most people, especially the novices and beginning students hardly read these directives. Some students even insert the disk into the computer in the wrong direction. Some paste the label to cover the disk's read/write openings. These lead to failures of the disk and thus jeopardize the stored information. Another form of ignorance identified is that after typing their documents, students save their file and then remove the disk without closing the file or exiting the application. This often leads to disk failure. And since these disks are being used in the exams, failure of the disk could mean failure at the exams.

However, another problem emerges as the students become “wiser”. Students easily bring disks to exams with information stored with the purpose of cheating. Opening the document from the brought disk and saving on another disk without first saving on the hard disk may lead to the failure of a disk. Moreover, during the exams, students often pass the disks to their colleagues, who simply copy the answer to a 3-hour exam within seconds. These lead to students passing without knowing the subject and thus become a problem in senior courses requiring knowledge of previous years. If such students manage to use the tricks successfully through the 3-year study, then such graduate becomes a problem in the job market, and also projects a bad image of the University.

Finally, the money spent on disks is very prohibiting. With about 2000 students needing about 6 disks per year, the department purchases about 12000 disks costing R54,000 (over \$7500) per year assuming each disk costs R4.50. And with a departmental operational budget of about R100,000 per year, these disk costs over half of the

operational budget. Additional costs are spent on other documents. Study guides and assignments were typed, printed, photocopied and given to students. The students' answers to the assignments were also typed and submitted physically to the lecturers. These resulted in enormous cost and wastage of paper, efforts and disks.

b) Problems of manual implementation of common tasks

Various tasks in the department were being done manually. A walk through the passage of the ICT faculty towards afternoon is usually hectic due to students queuing to book a space for open lab. This is similar to the queue for registration. Also, there is the problem of students who missed a class when assignments were distributed. Moreover, various other tasks were recognized to be in need for automation to enhance the services being offered.

c) Problems of lack of visible model of required outcome for Web Development courses

Students begin a Web development course without having a visible model of what they are expected to be able to accomplish at the end of the semester. This leads to a lack of motivation and "slow drive" in their studies.

d) High Cost and of standard e-Learning packages and its unavailability in other campuses

The Pretoria campus of TUT has a standard WebCT system in use. This has been acquired before merger. Four years into the merger, its use has not been extended to the Soshanguve and Garankuwa campuses. This is either due to higher licensing costs or other technical issues.

In summary, these led to the identification of the need for a prototype Web application as an alternative system that will reduce the identified problems. The developed prototype system is expected to be suitable for:

- Serving as a model of desirable outcome expected for 3rd year students. This is expected to will enhance effective teaching of dynamic web applications programming, as part of the curriculum for the Web Management specialization of the National Diploma in Information Technology.
- Electronic implementation of some common tasks (such as online booking for labs, online applications for registration, online assessment etc.) in higher institutions.
- Reducing the huge expenditure on the transfer of training and assessment documents, by providing cheap and secure alternatives to the old reliable floppy disks.
- Reducing the time and space wastage on the management of training and assessment documents, by providing online storage and retrieval.
- Increasing the productivity of web application programmers.

Thus, Dehinbo (2007) builds upon the success of Dehinbo (2004) by using the prototype to handle assessment beyond multiple choice questions, mix and match questions etc. It allows answering questions involving descriptive answers and even allows upload of external programming files.

The developed system was demonstrated to the students at the beginning of the semester, and the students were admonished to strive towards development of more functional applications at the end of the semester. It is observed that the zeal and enthusiasm of the students increased during the semester and the pass rate for the subject improved at the end of the semester. The study also had a significant impact on the IT diploma curriculum because the developed system serves as a model and an embodiment of major subjects in the NDIT curriculum namely: Internet/WWW+HTML, Networking, Scripting languages, Database and Project Management. That gives the students a focus and a goal. This is thus another evidence of how research aids teaching. Furthermore, prototypes of more complex Web applications involving features such as chat, security, student registration etc were developed and the students were then further challenged to develop such as group project. This, according to Hirschheim and Klein (1989) is a form of evolutionary learning from interaction with partial implementations as a way in which technology becomes embedded into the social perception and sense-making process. This is thus evidence of how research aids teaching towards equipping future generation towards ensuring sustainability.

Implicitly, the end product of this system overcome the high price burden of purchasing off-the-shelf applications that could accomplish some of the above tasks, by providing in-house developed versions of such applications. It also inculcates the attitude of "doing it" rather than "buying it" into prospective students.

Dehinbo (2007) is based on the assumptions that reality is socially constructed and the product of continual social interaction. We believe that higher institutions in developing countries should be self-sufficient in software development especially considering the abundance of human resources and human development efforts. The use of the developed Web application have the desired effect of motivating the students and serving as a reference point for putting developing countries into the mood for in-house Web application development rather

than the purchase of off-the-shelf packages that will have significant strain of their limited budget. Given the positive move towards Web and multimedia applications worldwide, the study therefore has the potential to assist higher institutions in developing countries in “dancing to the tune” of in-house web applications development.

In following the footsteps of India, we hope this would *stimulate* sustainable development in the software industry. We recognize that this can only be achieved one by one, step by step, institution by institution. Thus, Odunaike and Dehinbo (2009) examines Institutional e-readiness using the case of Tshwane University of Technology (TUT). And to check if the use of the Internet and web applications and related innovations in South Africa is gaining popularity at a quicker pace among students, Kademeteme and Dehinbo (2015) presents a study on Technology acceptance by first year students at selected South African universities. At this point, Technology acceptance by first year students is rapidly increasing. That brings us to the need for further research on various other educational tools for development in South Africa, and these are presented in the next section.

Educational tools for learning towards development in South Africa

One of the educational tools that could assist teaching in learning towards enhancing in-house Web application development is the use of Learning Management Systems. Thus, Dehinbo and Odunaike (2008) presents the study on the need, use and best practices for the implementation of Learning Management Systems in organizations and higher institutions”. Another set of educational tools that could assist teaching in learning towards enhancing in-house Web application development is the use of traditional Web 1.0 tools e.g. email and Web2.0 tools.

Thus Dehinbo (2008b) presents the study on contributions of traditional Web 1.0 tools e.g. email and Web2.0 tools e.g. weblogs towards knowledge management. Similarly, Dehinbo (2008d) presents Strategy for progressing from in-house training into e-learning using Activity Theory in a South African university. Dehinbo (2010a) presents tips on enhancing Collaboration and Knowledge Transfer on E-Learning and the Teaching of Web Application Development within Universities in Developing Countries.

Also, Dehinbo and Ojo (2011) presents a study on salient e-learning with web applications: the case of the Tshwane University of Technology. Learning Management Systems (LMS) cost much and need to be customized to specific organizational needs. The university could have benefited more by commissioning the development of such system in-house, thereby possibly saving funds and also developing local expertise while providing local job opportunities. After all, there is a Center for Technologies Innovation within the university that can be tasked with such development. There is also the department of Web and Multimedia Computing in the faculty of ICT within the university which could also assist. If those could not do it, there should be some software development companies within the country that could develop such system. It can also be argued that purchasing the Blackboard would be cheaper as the system is being sold to many other institutions around the world. It could also be said to be beneficial to staff and students by using a system with international standard and commonly used around the world.

The situation, according to Dehinbo (2007) becomes like the “ugly” situation of the mineral resources in Africa. Nigeria for example is a large producer of crude oil in the world. Yet, by the time the crude is exported to be refined in developed countries and re-imported back to Nigeria, ordinary people there find it difficult to afford petrol for their cars. Also, much as Ivory Coast is a large producer of cocoa which is exported for the manufacture of coffee and chocolates, an ordinary Ivorian can hardly afford a tin of coffee. Furthermore, South Africa is also a large producer of gold and yet we don’t see much South Africans wearing gold ornaments. To avoid the above scenario, Dehinbo (2007) quoted an indigenous African proverb that says: “If you give me a fish, I would be grateful, but I may ask again when I’m hungry. But if you teach me how to fish, then I would be eternally grateful as I may not need to ask again once I become self-sufficient and sustainable”. Dehinbo (2007) therefore infers that the use of the locally developed IT applications would have the desired effect of motivating a production rather than a consuming economy and thereby putting developing countries into the mood for in-house application development rather than the purchase of off-the-shelf packages that will have significant strain of their limited budget. Development of web applications is therefore critical to facilitate further learning to continuously stimulate the economy.

Dehinbo and Ojo (2011) thus presents the results of an action research on salient e-learning at the faculty of ICT in a South African university, Tshwane University of Technology (TUT) to emphasize the impact of incorporating guiding principles in in-house developed web applications for enhancing learning at the institution. These guiding principles include the provision of up-to-date relevant information, inclusion of multimedia components, facilitating culture of acknowledgement and appreciation, inclusion of repository of knowledge, facilitating culture of knowledge sharing and transferring knowledge, mentoring etc. The challenges encountered in the development and implementation of web applications incorporating the above guiding principles are also discussed.

And learning is not limited to educational institutions only. Organizations can also benefit from learning using the Web tools including those above. They can learn other ways of enhancing their business, and the beauty of web-based tools is that it allows one to learn from any other person in any part of the world, as long as they are connected to the internet. Even when they are connected to the internet for most part of a day, simple tools like email can still allow them to quickly receive and download learning materials. Therefore, the next section presents various studies we conducted towards utilizing Information systems for business enhancement.

ICT for Business Enhancement towards development in South Africa

Enhancing business is definitely one of the ways for a society to move towards development and sustainability. Thus, we conduct some studies towards this goal. And electricity is one of the keys to business enhancement. When we thought South Africa as a developing country is moving steadily in the direction of sustainable development, then the unthinkable happened in the availability of electricity to power educational tools, industries and even homes. Since 2008, the concept of load shedding or the rationing of the provision of electricity became a rampant problem in the society. That brings to reality what majority of other developing countries are facing that hinders their development. Given the South Africa is the most industrialized country in Africa, it becomes imperative to champion solutions in solving the electricity problem. In doing our part in this regard, Dehinbo (2011b) presents a study on *strategic analysis towards a solution framework based on the use of Information Technology control for the energy crisis in South Africa*. Even then, as I write this article in September 2022, the electricity energy crisis still continues and we are currently on stage 6 loadshedding meaning that there will be no electricity for 2 hours at a time and 3 to 4 times a day, totalling about 6 to 8 hours without electricity in 24 hours. However, Information systems still saves the face as the only solace we have is the use of an “app” to notify users in different parts on when to expect electricity to be off. This way, users are prepared ahead.

In appreciating the role that software development and enhancement can play towards economic development, Dehinbo and Dehinbo (2012) present a study on evaluating the South African software industry as a key component for economic development using an Ireland framework. Otto and Dehinbo (2012) presents a study on Search Engine Optimization for the Website of a South African Organization as an Internet Marketing Strategy. It is envisaged that Search Engine Optimization as an Internet Marketing Strategy could further position web applications towards being available for leapfrogging organizations into sustainable development.

And an important key for economic development involves getting people to study and specialize in areas that they are best suited to due to their background, qualifications, interests etc. Thus, Dehinbo and Mtsweni (2013) presents a prototype using participatory design on development and usability of a Web application for career choice for high school Students. Similarly, Sekele and Dehinbo (2017) presents a study on the design and development of a Course Recommender System for undergraduates. By working in a field or area or profession that people are best suited to, productivity is bound to increase and lead to economic development. Nyambi and Dehinbo (2018) development and evaluation a prototype of an Event Management System.

Mansell and Wehn (1998, p.9) explain that the application of ICTs as 'tools' for development offers opportunities to reduce some existing disparities in income distribution and the quality of life. These tools are being developed and applied in social and economic contexts involving increasingly complex webs of interactions between policymakers and those engaged in producing and using ICTs. Organisational and technical innovations are contributing to knowledge-based development and improving social, economic, and environmental conditions in developing countries. These interactions are occurring in the immediate presence of others, over the distance between one village and another, and across the globe.

They are generating new social and technological capabilities - beneficial ways of learning, governing, conducting business, and occupying leisure time. However, they are also giving rise to new forms of exclusion by virtue of gender, age, religion, ethnicity, language, or illiteracy.

Therefore, by and large, this reinforces the need for more studies on various ways of bringing development to those previously excluded due to their social status in the society. The next section looks at these.

Social inclusion through enhancement of Web applications

Mansell and Wehn (1998, p.9) explain that the least developed countries are at risk of being excluded from knowledge-based development. New approaches are needed to ensure that limited financial and other resources play catalytic and enduring roles in linking ICT applications to development needs. We note that sustainable development can only be achieved if more and more people in the society contribute towards envisaged development. And they can only

contribute if they are not socially excluded towards envisaged development. We therefore identify the need for studies on social inclusion for many people in the society. Thus, Dehinbo (2008c) discusses *suitable research paradigms for social inclusion through enhancement of Web applications in developing countries*. Also, Dehinbo (2009a) discusses enhancing knowledge access towards achieving social inclusion for the less privileged students in developing countries.

Social inclusion also implies catering for rural communities along with the urban communities. In this light, Dehinbo and Odunaiké (2009) present a study on adapting e-learning facilities to serve the rural communities in South Africa, using the case of the Soshanguve community as an example. Again, higher education institutions are expected to champion such developmental efforts.

An age-old profession responsible for economic development in many developing countries is farming, and as such, farmers should not be left out of using information systems for enhancing their output. Thus, Akinsola and Dehinbo (2013) present a study on Internet Enabled Platform for Bridging South African Emerging Farmers' Knowledge Gap. Dibakoane and Dehinbo. (2016) presents a study on the Intra Organizational Information Retrieval System for an Agricultural Research Institute in South Africa. Thus, Emerging Farmers can continually learn and tap from the knowledge of other farmers and use Information systems in various ways towards increasing their productivity.

Enhancing organizational systems using Information systems and Web applications

Again, in using higher education institutions to learn where and how enhancements can be effected in organizations as developmental efforts, Mabunda and Dehinbo (2012) develops a prototype system for a study on enhancing Online University Class Management System with Instant Email Feedback Alert. This could also further enable institutions that could implement such enhancements to even major software system in use, to gain competitive advantage on the road to sustainable development. If banks can develop similar systems email with instant email or SMS feedback for updates to the customers' money in bank accounts, why can't higher institutions which are the citadel of learning and champions of research implement such? Interestingly however, universities in South Africa are yet to implement this proposed solution ten years later in 2022.

In our university for example, it is possible for another lecturer to either knowingly or unknowingly change marks for other lecturers. Instant email feedback for updates to the Integrated Tertiary System (ITS) could have avoided such, as one can easily see if a mark currently changed now is done by someone else. Also, students still wait till the last few days of the semester or even beyond to come and request corrections to some of their missing marks.

It can be explained by university authorities that their failure yet to implement this proposed solution ten years later is due to the fact that they are locked down in multi-million dollars contract with the providers of such ITS system, and that requesting for changes or updates to the system could cost more million dollars. This is one of the reasons why change needs to be effectively managed. It is not enough to just develop even a beneficial system and expects it to be adopted and used. But then, how can developing countries progress in such situations? This is one of the reasons why significant part of this article is aimed at effectively managing change and encouraging in-house development of information systems. In line with Kotter (1995), some suggestions for managing general change include establishing a sense of urgency, creating a guiding coalition, developing a vision and strategy, communicating the change vision, empowering employees for broad-based action, generating short-term wins, etc. More information on this will be given in future studies, but the next section concentrates more on empowering employees for broad-based actions and generating short-term wins by encouraging in-house development of information systems.

In-house development of systems that could enhance collaborative Learning

In further demonstrating the need for in-house development of systems especially those that could enhance collaborative Learning, Iwasokun and Dehinbo (2015) presents a prototype for a study on "A Web-Based Virtual Classroom System for Collaborative Learning". Collaborative Learning can further be enhanced with the use of a blog-based system. Thus, Mashishi, Dehinbo and Dehinbo (2015) presents the Development of a prototype Blog System to Enhance Interactive Communication towards Supporting Learning. This addresses the limitation of the Blackboard system used by then, which cannot be accessed by students not currently registered for a subject and does not include the pictures of students in identifying participants in an academic discussion. Thus, it is possible for participants in an academic discussion to meet outside the class and not recognize on another.

Mashishi, Dehinbo and Dehinbo (2015) thus agree that in solving those limitations, participants in an academic discussion can continue the discussion even outside the class and even when they have graduated or are no longer registered for the subject. Thus, on a blog-based discussion on array processing optimization, even past students that

have passed the programming subject can pass knowledge to currently registered students. Akussah and Dehinbo (2018) discuss developing a prototype for a Marker-based Handheld Augmented Reality Application for Learning Mathematics.

Thinking of more ways to enhance learning, we note that the millennium generation are usually on social media on their phone. Therefore, why not exploit the possibility of learning using social media? Therefore, Dehinbo (2016) presents a study on using Facebook Social Network to Enhance Interactive Communication toward Supporting Learning in African Higher Institution. And we know that using social media involves abbreviating texts and using slangs to communicate within limited space available. It is thus important to normalize abbreviated texts and slangs. Therefore, Adedamola, Modupe and Dehinbo, presents a study on development and evaluation of a prototype system for normalizing Internet Slangs in Social Media Texts, so as to allow meaningful learning.

For sustainable development of the whole society, learning would not be limited to academic institutions. Business people and entrepreneurs also needs to learn more to enhance their productivity. Therefore, Maseko, Dehinbo and Dehinbo (2016) presents a study on the Development and Evaluation of an E-Learning System towards enhancing Entrepreneurial Skills. In not limiting learning to text-based systems only, Mdluli and Dehinbo (2016) presents a prototype for a study on the development of an Audio-Visual Based E-Learning System to Enhance Interaction between Learners and Teachers. Msiza and Dehinbo (2019) presents a prototype system to Visually Demonstrate the Key Concepts of Multimedia Fundamentals for Undergraduates. Shabane and Dehinbo (2019) presents a study on Developing and Exploring the Use of Virtual Reality Learning System to Teach Mathematics Toward Minimizing Failure Rate.

Also, Montshiwa and Dehinbo (2018) presents a study on multimedia application to assist Elders' in learning to use e-banking services. This is in line with the statement for sustainable development, one has to spend equal amount on energy spent on making money on keeping the money. And still on sustainable development of the whole society, children and pre-scholars should not be left out, in view of the general saying "catch them young". Noting that they would respond more to interactive multimedia elements for learning, Letsoalo and Dehinbo (2016) present a prototype study on enhanced Interactive Multimedia System as an Additional Learning Tool for Pre-Scholars.

And moving from learning among students and scholars into learning within organizations, Mokoeni, Dehinbo and Dehinbo (2015) presents a study on participatory Development of a Web-based Communication Platform for Organizational Learning in a Government Department. And a key to organizational learning is Knowledge Sharing because as more and more people share knowledge in an organization, then it gets to a point where the whole organization become learned. Therefore, Molete, Dehinbo, and Dehinbo (2015) present a study on an Innovative Knowledge Sharing System for Collaboration in the Public Sector using the Case of a South African Government Department.

And as the whole organization become learned, arrangements and plans need to be made ahead for future employees of such organization because staff members will definitely leave, age and retire while new staff members will be employed. But when the state of learning in the organization becomes enshrined in the culture of the organization, then organizational learning can continue to be achieved seamlessly. Continued seamless learning leads towards intelligence. And when intelligence is incorporated in different aspects of an economy, then the sky is the limit.

An aspect of the economy of developing countries that needs some works is integrity. Virtual learning would involve testing what the students learnt so far, and it is important to be sure that it is the learner taking the test and they are not fraudulently aided by other people. Also, without integrity, development cannot be sustained because people would become afraid of falling into fraudulent hands. Thus, towards incorporating intelligence to a goal of integrity, Iwasokun, Akinyokun and Dehinbo (2014) presents a study on Fingerprint Matching Using Features Mapping.

Furthermore, Moremi and Dehinbo (2017) presents a study on a Classification Framework for Detecting Malicious Email Contents. And, Mooki and Dehinbo (2021) presents a prototype study on using Computational Intelligence to Verify Electronic Signatures. The use of information systems is thus vital for maintaining integrity, seamless continuous learning, enshrined organizational culture, etc. towards sustainable development. The next section further discusses whether and how progress in software development and usage could lead to sustainable development?

Further Discussions

Can progress in software development and usage lead to sustainable development?

Mansell and Wehn (1998, p.11) explain that the former United Nations Secretary General Kofi Annan emphasises the enormous potential of information and communication technologies (ICTs) for development in these remarks to the

first meeting of the United Nations Working Group on Informatics. The Working Group is thus asked to assess the role of scientific and technological innovation as developing countries become more deeply engaged in building innovative 'knowledge societies'. In addressing the task, Mansell and Wehn (1998, p.7) explain that the Advanced microelectronics-based information and communication technologies (ICTs) are at the heart of recent social and economic transformations in both the industrialised and many developing countries. The costs of ICTs are continuing to fall while their capabilities increase. As their capabilities increase, they are being applied throughout all sectors of economies and societies. The increasing spread of ICTs opens up new opportunities for developing countries to harness these technologies and services to serve their development goals. In the last few years, there have been many initiatives at the highest levels of government and industry to promote the construction of a global information infrastructure. Developing countries are being encouraged to invest in their national information infrastructures so that they can participate in knowledge-based development and experience the predicted social and economic benefits.

Teczke, Bespayeva and Bugubayeva (2017) observes that training in skills and professional development of the IT workforce is critical and it is an important driver of development especially in the area of ERP (Enterprise Resource Planning). Thus, we look at ICT's impact on training and education as example.

Taking a look at software development and usage in educational institutions for example, I can recall the days when dissertations and project reports, question papers were typed on "stencils" and then duplicated. If there are errors, sometimes corrections can be made on the "stencils" though there would still be signs of the corrections on the final prints. sometimes however, a new "stencil" had to be made. Then came the use of word processors, and corrections can easily be made without signs of the corrections on the final prints. Moreover, the document can easily be stored and updated months and years later. And then with the use of educational tools like email, the document can easily be transmitted to other people instantly anywhere in the world.

Then came the paperless drive (i.e., reducing the use of paper in business processes). Xiong (2021) indicates that the paperless office is perhaps one of the most tangible examples of digitalization that has a positive impact on the environment while also providing major business performance benefits. Recall that Alcaraz and Bell (2014) explains that the creation of new knowledge should impact the three principles of sustainability (ecological, economic, and social). Thus, progress in the paperless drive is based on the potential to bring economic cost savings as we reduce printing costs. It also brings social benefits as soft copies can easily and quickly move around social circles like on social media thus forging social cohesion. And then, it also brings ecological benefits by resulting in less damage to the environment, as demands for papers reduce and less trees are used to produce papers, less water used in the bleaching process to produce papers thus also reducing environmental toxicity.

Xiong (2021) further observes that paperless business is a sound and important environmental practice, but it also contributes to better, more efficient business operations. Imagine the huge savings that could be made by having thousands of students writing tests from softcopies of question paper of say about 10 pages each? Then, let us escalate the scenario to several institutions in a country, and then further to the whole society.

We can then transpose advantages of the paperless drive indicated above with recent developments in simultaneous editable documents via SharePoint systems, and more recently video conference systems that made possible some form of virtual meetings during the recent worldwide lockdowns due to Covid-19 pandemic. Without doubt, the huge savings would have led to sustainable developments here and there.

In actual fact, all our previous studies presented above from Dehinbo (2004) up to Mooki and Dehinbo (2021) are aimed at contributing our quota to this drive for the change of having developing countries being leapfrogged into development (like India has been) through progress in Information Systems and Web application development. How far then are we on this drive? Here and there, there have been limited progress made especially with the advent of the portable smart phones that could access various systems in the society. These are however below reasonably possible expectations that could lead to competitive advantage. This suggests the need for further catalysts for planned and emergent change management. This would be addressed in further studies.

Catalysts towards using IT for development

A good example of how a needed well-managed IT-based change can bring development to a society is the management of the change to the use of Free and Open-Source Software. This is more paramount for two major reasons. First reason is that a free software could ease financial pressures on less privileged societies such as developing countries as they could be able to use Free and Open-Source software even though they cannot afford huge licensing fees for proprietary software. Second reason is that the availability of source codes for FOSS can enable viewing and learning from the codes, and in some cases even modifying the codes to improve or enhance

functionalities. As learning from these are entrenched in organizations, it could bring more favourable organizational culture that perpetuates learning for further development.

However, Dehinbo and Ditsa (2016) noted that in spite of the above, it is thus unfortunate and surprising that many Institutions of Higher Learning in South Africa are yet to utilize the full benefits and freedoms of FOSS to derive competitive advantage. Reijswoud and Mulo (2006) confirm this statement by indicating that “despite its obvious advantages, FOSS is not on the agenda for many decision makers in developing countries”. Bakkabulindi and Ndibuza (2015) also lamented the poor attitude to and hence the limited utilization of ICT innovations which includes FOSS. Furthermore, even to date in 2022, it is difficult to find literature that showed any change in attitudes towards the use of FOSS for competitive advantage. Search through the literature database could not yield sources indicating the widespread change to the use of FOSS in South Africa and even in Africa. Everyday experience also shows that dominant use of proprietary software like Microsoft’s Office by people is still continuing despite low funds for software purchases. One will struggle to find few people using Office.org for example even though it is available free of charge. Missing in this regard is the culture of encouraging and utilizing FOSS to save cost and enhance expertise especially in academic institutions due to the ability of inspect codes and learning from them as well as enhancing the codes thereby also further contributing to the society.

From all above, it is thus clear that attaining development and sustainability involves many processes and steps among which are: learning from others, doing the little one can do step by step, communicating and encouraging teamwork, knowledge sharing and knowledge management, change management, enhancing organizational culture and continuous organizations learning etc. This reinforces the synergy between actions, reflection and continuous learning as strategy for effective learning in organizations towards ensuring effectiveness. Thus, the next section consolidates this.

Action, Reflection and Learning

As noted earlier, Maguire et al. (2001) explains that action research seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities. This study therefore seeks reflection on previous intervention systems developed towards organisational learning. Jashapara (2011) explains that organisational learning can be broken down into two aspects which is the cognitive and the behavioral aspects. Behavioral is considered as single loop learning. This aspect promotes “doing things better” perspective. The various systems we have developed and presented from Dehinbo (2004) to 2021) could fall into this category. This can also be seen as new actions or responses that are based on existing understandings that if we develop these new systems, people will use it for the betterments of the society.

Jashapara (2011) also explains the cognitive aspect regarded as double loop learning. This aspect promotes “doing things differently” perspective. Developing countries has to embrace this cognitive part regarded as double loop learning, promoting “doing things differently” perspective due to their level of funding as compared to developed countries. An example is encouraging and utilizing in-house developed systems to save cost and enhance expertise in the society. Another example involves encouraging and utilizing FOSS to save cost and enhance expertise especially in academic institutions due to the ability of inspect codes and learning from them as well as enhancing the codes thereby also further contributing to the society. The fact that proprietary software such as Microsoft products dominates software use in developed countries does not mean developing countries should just follow such and neglect the prospects of utilizing FOSS to save cost and enhance expertise thereby freeing limited resources for other uses and maximizing human capital development. It should be noted that the population of India is around 1 billion and so also is the population of entire Africa around 1 billion. Maximizing such magnitude of human capital would definitely imply further contributing to the development and sustainability of the society.

Conclusion

This study examines multiple perspectives of innovation for sustainability, we discuss various previous studies using different methods that we consider necessary to stimulate or leapfrog developing countries into sustainable development. This is possible through progresses in individual and organizational learning leading to entrenched organizational culture enabled using Information Systems and Web application development for competitive advantage towards sustainable development in developing countries.

As a form of action research that seeks to bring together action and reflection, theory and practice, in participation with others, the study is in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities. Few things are apparent in this study. One is that given

the low financial situations, proactive actions and decisions need to be taken for developing countries not to be left out of sustainable development. Secondly, developing countries need to adopt both single double loop learning that promotes “doing things better” perspective as well as double loop learning that promotes “doing things differently” perspective. This will include seriously striving to benefit from the FOSS initiatives saving costs and enabling learning through the openness of software programming codes, thus encouraging in-house development of information systems.

Thirdly, in line with Kotter (1995), some suggestions for managing general change include establishing a sense of urgency, creating a guiding coalition, developing a vision and strategy, communicating the change vision, empowering employees for broad-based action, generating short-term wins, etc. The various prototypes in the various studies presented could be regarded as generating short-term wins worth being explored further by authorities towards sustainable development.

This study therefore seeks reflection on previous intervention systems developed, as well as the incorporation of theory and practice, in participation with other enabling factors such as knowledge management and knowledge sharing. These are relevant as strategies in Information Systems and Web Application Development towards competitive advantage for sustainable development in developing countries. This would be in the pursuit of practical solutions to issues of underutilization of Information systems which is a pressing concern to people, and more generally in the pursuit of competitive advantage for the flourishing sustainability and development of individual persons and their communities in developing countries. Central to this is that individuals, groups, organizations, and society continually learn and adapt new learning to ensure sustainability.

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