Information Technology (IT) Knowledge Management system stage model: A proposal for today's workplace

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Abstract

The human society is a knowledge based economy, that is, an economy in which information services are dominant as an area of growth. Knowledge workers exist to produce or analyze ideas and information, and also to manage knowledge in the knowledge economy. Knowledge management requires modern Information and Communication Technologies (ICTs) as tools to support the strategies, methods, techniques, processes in the management of knowledge. In this respect, this paper proposes an IT Knowledge Management system stage model for today's work place which takes account of modern ICT infrastructures including web based technologies, Mobile devices, teleconferencing and Video conferencing systems . An IT knowledge management also defines the IT skills gaps and suggests appropriate IT training to bridge the gaps

Keywords: *knowledge management, Information Technology, Skills gaps, IT training, strategic planning, system model.*

1. Introduction

By definition, knowledge refers to facts, feelings or experiences known by a person or group of people. It includes the level of awareness or consciousness or familiarity gained by experience or by learning (Collins, 2012). Knowledge has been identified as a key economic resource, comparable in value to labour and capital (Edvinsson (2000), and a critical resource and source of competitive advantage in the modern global economy (Lee & Kim, 2001; Chivu &Popescu, 2008; Roberts, 2009; McFarlane, 2008; Giju, Badea, Lopez Ruiz & Nevado Pena, 2010). According to Giju, Badea, Lopez Ruiz & Nevado Pena (2010), knowledge in an organization occurs when a person makes use of what he or she knows, and the information it has available to solve a problem or to develop a project

The human society is a knowledge based economy, that is, an economy in which information services are dominant as an area of growth. However, the knowledge economy differs from traditional economy, in that the economics is not of scarcity, but rather of abundance of information and knowledge which can be shared, thereby encouraging growth through application, rather than being depleted with use (Mason, 2015). Hence, knowledge workers exist to produce or analyze ideas and information, and also to manage knowledge in the knowledge economy.

According to Avison and Fitzgerald (2006), knowledge management concerns getting information to the appropriate people, when required, helping them to share the information and experience, enabling them to use it to improve organizational performance, and putting all that in action for a specific purpose. Zyngier (2003) further noted that knowledge management is a business focussed approach to the collection of processes that govern the creation, dissemination, and utilization of knowledge to fulfill organization objectives thereby adding value to and increasing the productivity of an organization. As a field of study, it is concerned with simplifying and improving the process of sharing, distributing, creating, capturing, and understanding knowledge (Gottschalt, 2006). Tiwana (2000) identified 24 key drivers that make knowledge management important for organizations. The key drivers are further categorized into 6 groups namely:

- Knowledge centric drivers. These drivers focus on the fact that important knowledge exist within an organization but it is not effectively utilized. The drivers-index include the following items (ibid):
  - The failure of companies to know what they already know
  - The emergent need for smart knowledge distribution

- Knowledge velocity and sluggishness
- The problem of knowledge walkouts and high dependence on tacit knowledge
- The need to deal with knowledge hoarding propensity among employees
- A need for systematic unlearning

- Technology drivers. These drivers suggest that every organization has got equal access to technology and can only achieve competitive advantage by the efficient and innovative use of organization's knowledge. The key factors of technology drivers include (ibid):
  - The decline of technology as a viable long term differentiator
  - Compression of product and process life cycle
  - The need for a perfect link between knowledge, business strategy and information technology
- Organizational structure – based drivers. Internal and external factors could produce great changes within organizations, and these changes might lead to the loss of organization's knowledge. It is therefore very vital that organizations pay attention to their knowledge management irrespective of any kind of structural changes. The driving factors to consider include (ibid):
  - Functional convergence
  - The emergence of project centric organizational structures
  - Challenges brought about by deregulation
  - The inability of companies to keep pace with competitive changes due to globalization
  - Convergence of product and services
- Personnel drivers. Changes in personnel could also lead to loss of skilled and experienced staff. Personnel drivers include(ibid):
  - Wide spread functional convergence
  - The need to support effective cross functional collaboration
  - Team mobility and fluidity
  - The need to deal with complex corporate expectations

- Process focused drivers. People may not see the knowledge gained by others and this makes room for repetition of unnecessary tasks. Process focused driving factors include(ibid):
  - The need to avoid repeated and often expensive mistakes
  - The need to avoid unnecessary reinvention
  - The need for accurate predictive anticipation
  - The emerging need for competitive responsiveness
- Economic drivers
  - The potential for creating extraordinary leverage through knowledge; attractive economics of increasing returns
  - The quest for a silver bullet for product and service differentiation

Although knowledge management is a new discipline, it is a key resource for competitive advantage, and requires modern Information and Communication Technologies (ICTs) as tools to support the strategies, methods, techniques, processes in the management of knowledge. In this respect, this paper proposes a Knowledge Management (KM) system stage model for today's work place which takes account of modern ICT infrastructures including web based technologies, Mobile devices, teleconferencing and Video conferencing systems . An IT knowledge management also defines the IT skills gaps and suggests appropriate IT training to bridge the gaps.

2. Problem statement

The need to acquire and disseminate relevant knowledge within organizations cannot be overemphasized. Although the tools and techniques for knowledge creation, acquisition, storage, processing, retrieval and dissemination do exist, however, most models of knowledge management in the organizational context are often incomplete in IT structure due to the fast changing nature of IT infrastructure. For instance, the model proposed by Gottschalk (2006), and Gottschalk (2002) have not taken into account new technological advances such as communication and collaboration technologies in today's work place: web based systems for Internet and Intranet/extranet usage, mobile technologies and devices such as PDA's, PCs, teleconferencing and videoconferencing systems. Today's work place requires the use of, and application of new technologies properly organizes and harnessed for competitive advantage.

3. Aims and objectives

The objective of this paper is to examine the ideal work place, the ideal technologies needed in today's work place, and to evolve appropriate IT knowledge management system stage model which is relevant in today's knowledge economy. By doing this, necessary IT skills gaps are identified among organizational workers and appropriate trainings provided for the them to bridge the skills gaps

4. Knowledge Management in the workplace

With the advances in hardware and software technologies, organizations aim to achieve competitive advantage over others through the maximum use of available IT infrastructures, technologies and innovative knowledge management approaches. Murray (1998) suggests that Information and Communication Technology (ICT) is a facilitator and a tool for transfer of explicit knowledge across functional boundaries of knowledge. From the hierarchical point of view as presented in Godbout (1999), knowledge encompasses information, which in turn encompasses data as shown in figure 1. The totality of data, information, and knowledge acquired by a person or group of persons leads to wisdom. Data is seen as raw facts which include text, numbers, tables etc in a database. Information on the other hand is processed, meaningful and useful data, while knowledge is considered as a renewable or re-usable asset of value to the firm. Information exists in the organizations records or databases while, knowledge exist in the peoples mind. The role of ICT, however, can be seen as applying knowledge in providing access to sources of knowledge, gathering, storing, offering valuable search and retrieval methods to locate the required information; and transferring knowledge to supporting the development of individual and organizational competencies.

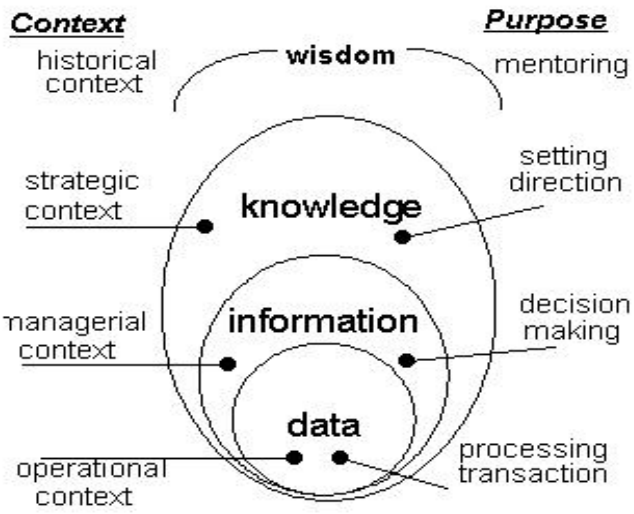

Figure 1; Hierarchy of meanings (Godbout,1999)

Godbout (1999) argued that data do not carry meaning except an individual understands the context in which the data were gathered. Information includes data, and also all the information a person comes in contact with as a member of a social organization. Information becomes individual knowledge when it is accepted and retained by an individual. Equally, organizational knowledge exists when it is accepted. However, common knowledge does not need to be shared by all members to exist. According to (Nonaka and Takeuchi, 1995), knowledge exists in two forms, tacit and explicit. Tacit knowledge is more difficult to qualify and is contained in people's mind. This can be learned only by experience and communicated indirectly through demonstration. Explicit knowledge is everything that can be documented (manuals and procedures), archived, or codified and can be shared. Technology is a means of transfer of explicit knowledge that will allow internalization of knowledge and its incorporation into the understanding and experience of the individual.

Also, Dixon (2000), identified technological tools as facilitators and practical means of knowledge integration at national and global level. Abdul Kazi (2001) argued that whilst technologies designed to manage data are structured, numerically oriented and address large volumes of observation, knowledge technologies deal more frequently with text rather than numbers. Technology alone will not make organization knowledge – creating firm. Since knowledge technologies are more likely to be employed in an interactive way by their users, the roles of people in knowledge technologies are vital to their success. The level of expertise of individuals in using particular knowledge technology, team composition and dynamics are likely to impact on the decision of the choice and take up of IT tool and hence the full exploitation of the IT tools for managing knowledge

Matthews (1997) investigated notions of learning and knowledge in the workplace using an open systems approach. The paper discussed ways to the future through continuous learning, knowledge creation, and new organizational structures and designs.

Seng, Zannes,& Pace (2002) argue that increases in workplace learning may occur concomitantly with ways in which knowledge is managed in an organization, and that knowledge management effectiveness may be a function of how successfully an organization is able to put a technological infrastructure into place. Furthermore, an appropriate mix of technological equipment is pivotal to both knowledge management and enhanced workplace learning. They suggested that the cultivation of a climate and culture that support and encourage knowledge sharing and learning to occur may be more important than any of the technological advancements to assure enhanced workplace learning.

Massingham(2014) evaluated a range of best practice knowledge management (KM) ideas used to manage knowledge resources. In total, four KM toolkits and 16 KM tools were tested over a five-year period (2008-2013), as part of a large-scale longitudinal change project. Each tool was assessed against an evaluative framework designed to test criticisms of KM: strategy, implementation and performance. The results provide empirical evidence about which KM tools work and which do not and why, and outcomes for practitioners, researchers and consultants.

Gao, Li & Clarke (2008) studied the essence of knowledge management in organizations from a perspective of critical systems thinking, and suggested that knowledge management in business organizations has the task of managing the activities of knowledge workers or the transformation and interaction of organizational "static substance knowledge" and "dynamic process knowledge" for "products, services, and practical process innovation" and, at the same time, "creating new or justifying existing organizational systematic knowledge". They concluded that knowledge management is not simply about recording and manipulating explicit knowledge, but needs to address that which is implicit, and from which benefit can therefore be derived only through process rather than content.

5. Approaches to knowledge management in the workplace

Several researchers have come up with stage models of knowledge management, but as organizations expand and also technologies change over a period of time, these models depending on focus, may have fallen short of organization's expectations with ever changing business environments. For instance, the model proposed by Gottschalk (2006, 2002) does not include communication and collaboration technologies**.** Lee & Kim (2001) proposed a four stage Knowledge Management maturity model for understanding of the KM life cycle within organizations which is ideally inclusive. The stages were identified as Initiation, Propagation, Integration and Networking (Fig. 2). They also proposed four management objects within the knowledge management framework namely organizational knowledge, knowledge workers, knowledge management process and information technology (fig.3)

	Initiation	Propagation	Integration	Networking
Goals	Preparation for enterprise-wide knowledge management efforts	Infra-building and activation of knowledge activities	Integration of knowledge management efforts to organizational outcomes	Linking knowledge management to external partners
Organizational Actions	Disseminate the needs of knowledge management Assess current problems of knowledge management Make and share the visions and goals of knowledge management Make a long-term knowledge management plan Conduct benchmarks or pilot projects	Set up a preliminary knowledge management process Build a reward system Develop HRM programs (education, career path, recruiting) Develop a knowledge typology Build a knowledge management system with a knowledge base Conduct events to activate knowledge activities	Evaluate the effectiveness of knowledge Scan the changes of environmental needs Monitor and control knowledge management activities Define and focus on core knowledge areas Disseminate best practices of knowledge management	Analyze internal and external knowledge management efficiency Make knowledge alliances with partners Share knowledge management visions and goals with partners Link knowledge management with partners' Facilitate & manage inter-organizational knowledge sharing and collaborations

Fig.2. Stages of organizational knowledge management development
Source (Lee & Kim, 2001)

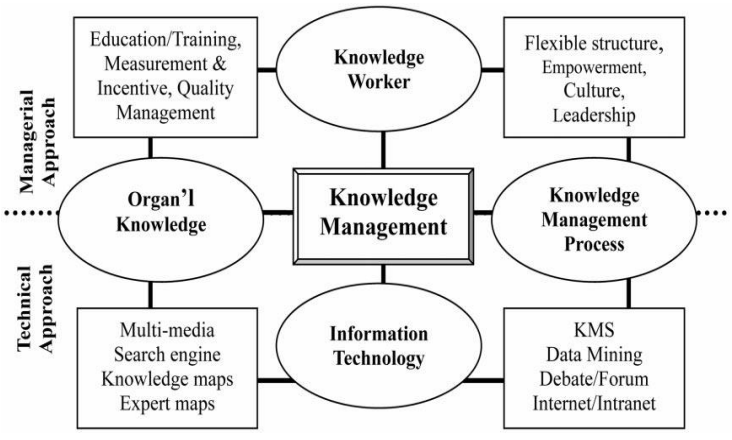

Fig. 3. Object and organizational approaches
Source: Lee & Kim (2001)

From these models, the role of education and training as well as the role of Information technology in knowledge management is obvious from the observed links in fig 3.
Managing knowledge in today's work place requires workers at all levels of management to be fully abreast and skilled in the use of necessary hardware and especially software technologies for today's work place (fig.4). Essentially, today's workplace requires the following software technologies as shown in fig. 4:

i. Web based Technologies. Most transaction processing systems existing in today's workplace are web based. The benefits of this include increased user awareness of the organization presence, products and services, a 24- hour access for users globally, as well as improving the usefulness and usability of the interface design of the organization's information system (Kendall & Kendall, 2013)
ii. Enterprise System Applications. Organizations integrate all of their information systems existing on different management levels and within different functions. Integration could be in form of Service Oriented Architectures (SOA), which exist in layers including the Enterprise systems at the top layer. Examples of popular Enterprise Resource Planning software are SAP and Oracle. Interestingly, these software support enable the migration of enterprise onto the web
iii. Wireless applications and Mobile Apps. The presence of Wireless local Area Networks (WLANS), wireless fidelity networks (Wi-Fi), Mobile devices and PDAs (3G, 4G technologies – Apple iphone, ipods, Blackberry) enhance strategic level operations in particular and high level organizational managerial functions in general.

With this development, managing organizational knowledge in the workplace of today requires that organizational workers be trained at each level in the use of available and necessary technologies. In this paper, we make modification on existing knowledge management models to include relevant aspect of software technologies considered very useful in today's workplace.

6. Proposal of IT Knowledge Management stage model

Using Lee and Kim (2001), we propose an IT knowledge management stage model encompassing relevant IT education and training on the use of hardware and software technologies at various organizational levels as shown in figure 5.

i. Basic Computer Literacy – Operational level
ii. End User Support Training – Knowledge level
iii. Information /Customer Support Training – High level
iv. Executive Management Training – Strategic level

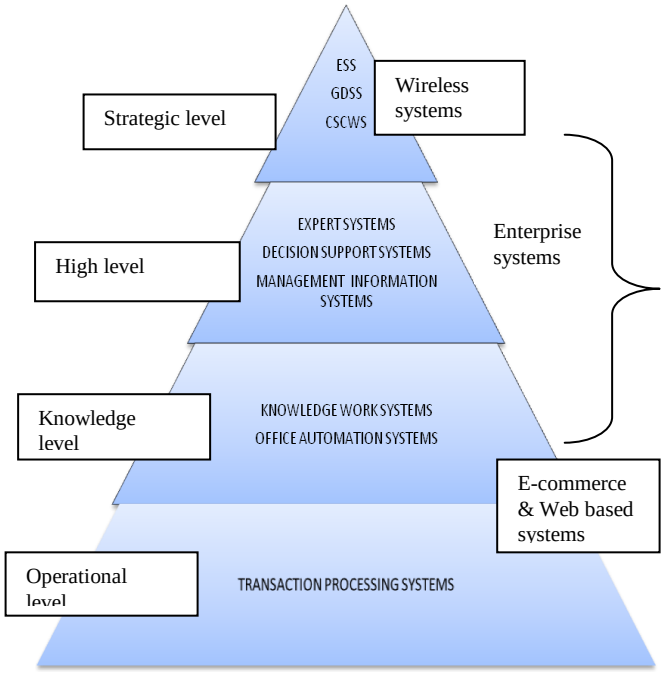

Figure 4. **Integrating Technology in the work place**

A model that capture these format is depicted in figure 5

	Initiation	Propagation	Integration	Networking
Goals	Goals as in Lee & Kim (2001)	Goals as in Lee & Kim (2001)	Goals as in Lee & Kim (2001)	Goals as in Lee & Kim (2001)
Management	Organization action as in Lee & Kim (2001)	Organization action as in Lee & Kim (2001)	Organization action as in Lee & Kim (2001)	Organization as in Lee & Kim (2001)

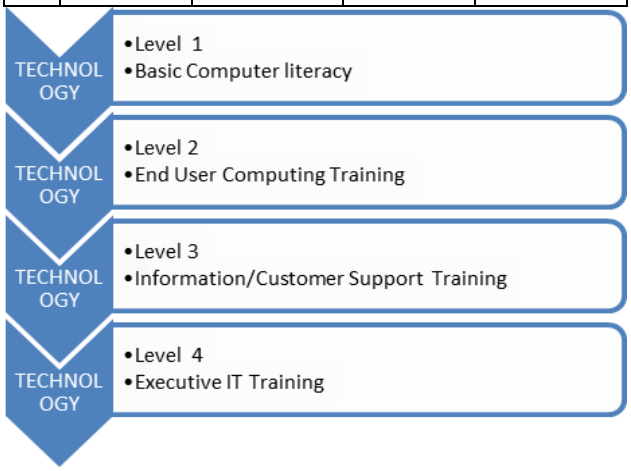

Fig 5. IT knowledge management model
(Focus is on the technology side)
Adapted from Lee and Kim (2001)

This training approach is necessary for comprehensive and continual skill formation which benefits both the individual, the team (workplace team) and the enterprise (Ford, 1991). It should be noted that our focus is on the technology side of Lee and Kim's model. The suggested IT training follows a gradient (rising) pattern as shown above in figure 5. Details of these trainings are provided below.

Operational Level Training (Basic Computer Literacy)
The operational level of management in organizations deals with transactions processing. The ideal organization has got computer base information systems in place. Therefore, operational staff must have basic computer skills to be relevant in today's organizations. The necessary computer skill at this level include the word processing, data entry, use spreadsheet and other user application packages relevant to the organization. Ability to operate other office technologies including photocopiers, telephones and switch boards are also necessities for most operational staff.

Knowledge Level Training (End User Computing Training)
More specific to organizations are the knowledge workers for the organization. These are professionals in the provision of organization's services. This set of people need specific end user trainings in software and hardware technologies needed to provide services in the organization. The knowledge level of organizations provides two classes of systems namely: Office automation systems (OAS) and Knowledge work systems (KWS). Kendall & Kendall (2011) noted that office automation systems support data workers who do not usually create new knowledge but rather analyze information to transform data or manipulate it in some way before sharing it with, or formally disseminating it throughout, the organization, and sometimes beyond. Examples of OAS include user application packages such as word processing, spreadsheets, desktop publishing, electronic scheduling, and communication systems through voice mail, email, and teleconferencing. Knowledge work systems (KWS) support professional workers in organizations in their efforts to create new knowledge. Workers at this level of organizational set up need enterprise wide organizational training in the use of Enterprise Resource Planning software such as SAP and Oracle in addition to skills in office automation systems (OAS).

High Level Training (Information Customer Support Training)
This level requires skills in the use of Expert Systems (ES), Decision Support Systems (DSS), and Management Information Systems (MIS). The high level organizational training targets managers who need specific trainings in in the use of appropriate specialized hardware and software tools in addition to skills in the use of enterprise wide application software tools SAP and Oracle. With such skill, they can generate information needed for appropriate managerial decisions from the organizations knowledge base. An ES is a knowledge based system, while DSS and MIS also provide Information bases for the organization's decision support and management information.

Strategic level Training (Executive Management Training)
The strategic level in organization support executive functions for long term organizational goals. This level requires skills in the use of Executive Support systems (ESS), Group Decision Support Systems (GDSS) and Computer Supported Collaborative Work Systems (CSCWS). Organizations increasingly rely on groups or

team decisions. GDSS are used in special rooms equipped with appropriate technologies and specialized software tools for collaborative and virtual group decision meetings. The ideal organization provides all the necessary hardware and software technologies which enable them compete and thrive in the dynamic business environment of the century.

7. IT Skills Gaps Analysis for Industrial application

In the light of continuous advancement in IT, new knowledge and experience is expected of organizational workers to be competitively relevant in the work place. Appropriate and up-to-date IT skills are expected of graduates from universities and other training institutions in line with current industrial trends.

A skill gap analysis is a systematic review of the skills held by individuals in a company (Clerk, 2012, UKCES). According Dungan (2013), QFinaance (2009), and UKCES (2013) the steps in skill gap analysis are identified as follows:

i. Identify all skills required by an individual to carry out their job role effectively
ii. Identify and categorize critical and non critical skills required to achieve a higher standard of work
iii. Compare the list of required skills with the actual skills possessed by the individual employee
iv. Use the result of skills gap analysis to develop training plans, support performance appraisals and justify pay reviews
v. Use the skills gap analysis to identify staff who have knowledge in particular areas as well as those who lack certain skills in order to facilitate mentoring within teams

Table 1 below shows skills gaps concerns among IT industry firms Vs Skills gaps concerns among firms in other industry verticals according to recent study in the United States of America. From the table the IT skills gaps concerns among IT industry firms as well as among other non IT firms are shown in the order of priority. All areas of IT skills gap identified require appropriate trainings through the universities and IT training institutes. Similarly, Table 2 shows the factors that contribute to IT skills gaps in various types and sizes of firms. For small, medium and large firms, the highest rated factors affecting IT gaps skills are the fast changing rate of technology, the lack of resources for IT skills development and the fact that IT education does not sufficiently translate to workforce performance. The later factor simply suggests that organizational workers need further professional IT trainings to fit the IT skills need of the industries as new technologies continue to emerge.

8. Summary and conclusion

Our proposed model could enhance workplace knowledge and experience of knowledge workers and entire organizational staff in the use of appropriate software tools needed in the workplace. Such knowledge and experience will be discernible in improved staff competencies, in the performance and capability of the organization (Matthews, 1997). As knowledge is nurtured and created in communities of practice (ibid), providing target based IT training opportunities at various levels for organizational staff will enhance office performance in today's technology oriented and potential paperless office . Training can be done off site or in house. Appropriate university departments such as those in computing and related disciplines should take leading roles in developing curriculum with industry focus to bridge the IT skill gaps needed by the industries in their operational environments. Table 3 below presents such efforts at enhancing IT skills training at the University of Botswana, Department of Computer Science. The Department of Computer Science has a Professional Academy in partnership with international professional academies and testing centres for the following IT professional training skills namely Cisco Networking Academy, Microsoft Academy, SAP, Oracle and Pearson VUE (CS handbook, 2015/2016) in addition to the regular academic computing science programmes offered at both undergraduate and post graduate levels.

Table 1. Skills gaps concerns among IT industry firms

Skills gaps concerns among IT industry firms	Skills gaps concerns among firms in order industry verticals
Data base/Information management	Security/ Cyber security
Networks/ Infrastructure	Networks/ Infrastructure
Server/data center management	Data base/Information management
Security/ Cyber security	Server/data center management
Help desk/ IT support	Storage / data back up
Data analytics/ business intelligence	Web design / development
Web design / development	Help desk/ IT support
Application development / programming	Data analytics/ business intelligence
Virtualization	Virtualization
Storage / data back up	Enterprise resource planning (ERP)
Cloud computing – laas or Paas	Customer relationship management (CRM)

Source. CompTIA, State of Skills gap report

Table 2. Perceptions of Factors that contribute to IT skills Gaps

Factors	Micro Firms	Small Firms	Medium Firms	Large Firms	IT industry Firms	Non IT Industry Firms
Fast changing technology- difficult for IT workers to Stay current with skills	39%	49%	49%	48%	48%	45%
Lack of resources for IT skills development	45%	48%	39%	41%	38%	45%
IT education/training does not sufficiently translate to IT workforce performance	31%	35%	48%	44%	45%	36%
IT pay is too low in some areas	20%	33%	35%	28%	31%	28%
Difficult to conduct on the job training for IT workers	20%	25%	26%	20%	25%	22%
Competition for limited pool of skilled IT workers	16%	16%	22%	25%	26%	17%
Insufficient focus on STEM education	16%	16%	15%	14%	25%	12%
IT careers do not attract the best and brightest workers	10%	4%	12%	12%	16%	7%

Source. CompTIA, State of Skills gap report

Table 3. SAP ERP skills training offered by Computer Science Department, University of Botswana.

Year	**2012**	**2013**	**2014**	**2015**
Total	27	49	43	26
Skills Acquired	ERP Process orientation and Integration of ERP software; Logistics: Materials Management, Sales distribution, and Accounting			
	Integrated Business Processes with SAP ERP (TERP 10); Organization structures, Master Data, ERP Transactions and Integration points			
Skill Levels	Knowledge level training Higher level training			
Trainees	Lecturers, Management Staff, Technicians/Technical staff, graduate/undergraduate students			

Source. CS SAP ERP Academy 2015

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